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Bringing in the Outsider

Vast sums of money have been spent in recent years on the mechanization of foundry processes. Correspondingly, between the two wars, foundries were modernized in the light of information and plant then available. In these earlier cases some managements were so pleased with the results, that, convinced they were right up to date, basked in that notion for a decade or more until it was perfectly obvious that their plant and methods were obsolete. Fortunately, not all managements were so short-sighted; one Midlands foundry within the space of five years, semi-mechanized, using roller pathways, then fully mechanized and finally, using the accumulated experience, built themselves an entirely new foundry on a better site. Thus the foundries which undertook mechanization about 10 years ago may now have reached the stage when complacency is likely to be encountered, and this must be guarded against.

The New Year is an appropriate time for appraising the efficiency of the plant under ones control in a quite realistic manner. Maybe, it is thought that as the spectator sees more of the game than the players, an outside opinion should be sought. This seems sensible, providing that the spectator has played and is familiar with the technicalities of the game. An American's views on the proficiency of players in a cricket match would seldom be worth listening to, or for that matter our own opinions on baseball. If an outside opinion be thought desireable, the first step to take is to ascertain what is available within the industry. There is a handful of high-grade consulting engineers who have specialized in foundry methods and organization; there is the now well-experienced team available from the British Cast Iron Research Association and the new service announced by the Association of Bronze and Brass Founders. Good advice on some of the problems can be had from the development departments of the larger firms and groups of concerns associated for this very purpose.

Despite the great resources of the industry and those allied to it, it may be desirable to call on the services of what are generally known as "efficiency" experts, because of the real importance of work simplification and the potential contribution to be made by the methods engineer. Here, much caution is required, because some of these concerns are past-masters at costing and will go to some length to ascertain arithmetically the category into which the majority of the defective castings fall, but yet offer no sound advice as to cure. In truth, this is useful information but it should be available without the help of outsiders. Where a foundry is making large quantities of similar castings, the problem of simplified handling will always be present and it would appear that either a special department should be created—and this has been done with marked success—or a reputable firm of specialists on the subject should be employed. This should do much good, but what must never be done is virtually to delegate the running of a works to an outsider—no matter how great his success as a consulting engineer.

HENRY GARDNER, J.P., M.I.Mech.E.

Managing Director of Glenfield & Kennedy, Limited, of Kilmarnock.

Leaders of the Industry

HENRY GARDNER, J.P., M.I.Mech.E.

IT is axiomatic that to become a successful journalist it is necessary to wear out the soles of your boots rather than the seat of your pants. It would appear that this is equally applicable in industry, for though Mr. Gardner has spent all his life with one firm—Glenfield & Kennedy, Limited, of Kilmarnock—rising to the position of managing director, he has never missed an opportunity to acquire knowledge through travel. It is this, no doubt, which inculcates the pioneering spirit in an engineer. An early venture in this direction was the great advances which he sponsored in the founding of green-sand castings of exceptionally large size, such as, for instance, the making of 10 ft. dia. valve bodies. The saving in fuel-handling costs and time on such a job is not inconsiderable. The installation of an impeller rammer in an engineering foundry was likewise a pioneer venture.

Glenfield & Kennedy being hydraulic engineers, their castings must obviously be sound, and under Mr. Gardner's enthusiastic leadership, all the necessary steps have been taken to ensure such quality, but with a complete elimination of extravagance. The size and weight of the feeding heads have been reduced; the aids of the Meehanite process have been harnessed; mechanized production has been organized, but above all, tidiness in all its aspects has been deemed of outstanding importance, especially in the promotion of good craftsmanship. To quote Mr. Gardner's own words: "a works is an organization of people who, given the conditions, tools and training, can achieve much." Another of his precepts is well worth assimilation by other industrialists. It is: "My policy has always been for a high standard of workmanship and quality of material, and my instructions and guidance to the inspection department and foremen is that they have constantly to keep before them that customers are paying good money for the firm's products and they must never allow any machines to be sent out, which, if they themselves were the customer, they would not willingly pay for and accept."

Mr. Gardner, who is a Justice of the Peace, holds membership in the Institution(s) of Mechanical Engineers, and of Production Engineers, and the Institute of British Foundrymen. He has travelled very extensively in the United States, Canada, Germany, Sweden, Egypt, Turkey and Greece. Besides being president of the Kilmarnock Chamber of Industries and chairman of the Engineering and Allied Employers' Kilmarnock District Association, he is also chairman of the local Employment Committee of the Ministry of Labour and National Service. The holder of this last office must according to the Ministry be "a person held in local regard, having a knowledge of industrial conditions and likely to secure the good will of both sides of industry."

Amongst his many activities he is also a director of the following companies: J. Blakeborough & Sons, Limited; the British Pitometer Company, Limited; Hydrautromat (1931), Limited; the North British Steel Foundry, Limited; and Ailsa Shipbuilding Company, Limited.

Like most Scots, Mr. Gardner is a keen golfer, and is fortunate in having the famous Troon course close by. Farming, which he takes quite seriously—he owns a small property—takes up much of his limited spare time, but affords him an interesting distraction from engineering and foundrywork.

Acknowledgements

Greetings cards and gifts of diaries and calendars are gratefully acknowledged from the following, and the good wishes of their donors for 1954 are reciprocated:—

Marco Conveyor and Engineering Company Limited; G. W. Beresford; F. Perkins Limited; David Brown-Jackson Limited; Eyre Smelting Company Limited; W. R. Buxton; The Gas Council; Davidson & Company Limited; John Sissener; W. Gibson; Société des Fonderies de Pont-à-Mousson; Ferranti Limited; Frank Rowe; Foundry Suppliers Limited, Frank Evans; E. Longden; British Industrial Plastics; Frodair Limited; High Duty Alloys Limited; Tin Research Institute; F. H. Lloyd and Company Limited; Noël Newman; K. & L. Steelfounders and Engineers Limited; Quentin Lumsden; International Alloys Limited; Allied Ironfounders Limited; T. A. Hammersley; Kenneth Marshall; Foundry Services Limited; Mr. & Mrs. Augstein; Alumin Limited; Stewarts and Lloyds Limited; W. Edwards & Company (London) Limited; Widnes Foundry and Engineering Company Limited; North Eastern Iron Refining Company Limited; Ruston & Hornsby Limited; Mond Nickel Company Limited; British Oxygen Company; F. & M. Supplies Limited; Western Foundries; Monsanto Chemicals Limited; Miss Bremner; Bradley & Foster Limited; Aluminium Development Association; Hobkirk Sons & Company Limited; Holman Bros. Limited; Cowlishaw Walker & Company Limited; Zinc Development Association; J. J. Sheehan; Lancashire Dynamo Group Publicity Services; Mary and Colin Carter; S. A. Ph. Bonvillain & E. Ronceray; *Metal Industry*; M. et Mme. P. Muguet; Educational Productions Limited; E. Weiss; Newcast Foundries Limited; F. W. E. Spies; E. Preston; Birlec Limited; Stein & Atkinson Limited; Butterley Company Limited; Northern Manufacturing Company Limited; Projectile & Engineering Company Limited; Max Davies; Fairbairn Lawson Combe Barbour Limited; Catton and Company Limited; Baron Krayenhoff; Clark Matthew; Charles Hervey; Constructional Engineering Company Limited; Tyseley Metal Works Limited; B. Levy & Company (Patterns) Limited; Incandescent Heat Company Limited; R. J. Richardson & Sons Limited; Comité de la Foire de Paris.

Of Importance to Master Patternmakers

A general meeting, to which all master patternmakers are invited, is to be held in the Queen's Hotel, Birmingham, at 2.0 *for* 2.30 *p.m. on Wednesday, February* 3, 1954*; admission by business card. The purpose of the meeting is the formation—if deemed desirable—of an association of master patternmakers. Master patternmakers who would like to attend to express views, but who are prevented from doing so by the exigencies of business, are invited to record their opinions for presentation at the meeting by writing privately to Mr. B. Levy,* 3 *to* 5*, Osbert Street, London, S.W.*1*, who is acting as convenor.*

Foundry apprentices of the Staveley Iron & Chemical Company, Limited, with some of the castings they have produced after a 6*-months' course in the firm's new training centre. It will be remembered that details of this company's splendid training facilities for foundry apprentices were given in the* JOURNAL (June 18, 1953) *soon after it was occupied.*

CAMBRIDGE INSTRUMENT COMPANY, LIMITED, have opened a repair and service depot at 7, Norfolk Court, Norfolk Street, Glasgow, C.5.

THE NORTH BRITISH LOCOMOTIVE COMPANY, LIMITED, Glasgow, have received an order from British Railways for five 200-h.p. Diesel hydraulic shunting locos.

COPIES OF THE TREASURY ORDERS (Statutory Instruments, 1954, Nos. 1, 2 and 3) making changes in the rates of Purchase Tax for certain goods (including domestic equipment) as announced earlier this week are obtainable from H.M. Stationery Office, Kingsway, London, W.C.2. The changes became effective yesterday.

Master Patternmaking Aids Production*

By H. Wilson

[SLIGHTLY ABRIDGED]

It is not intended in this Paper to cover every aspect of the very complex craft of patternmaking, but rather to bring forward a few of the problems and difficulties which have arisen and also to illustrate the methods which were adopted to surmount these obstacles. No claim is made that these difficulties are peculiar only to any one patternshop, but are rather the legacy of patternmakers the world over; indeed it is these exacting demands which lift the trade into the meagre ranks of craftsmen of the engineering industry. Although it is true to say that there was mass production in the foundry on quite a large scale prior to the last war, there is no doubt its application has been widely expanded both during and since that time owing to the greatly increased demands for castings. To keep pace, foundries have been obliged to analyse their particular production problems and the result has been much more reliance on high-grade work by the master patternmaker.

One common factor facing founders is the shortage of skilled labour, necessitating the conservation of such skill as exists to work which demands it and resulting in the introduction of every conceivable device to save the skilled moulders' time. Not least of this trend has been the provision of better pattern equipment, this obviously becoming more and more emphasized as the size of the casting is reduced or the quantity increased. As a result, founders who 15 years ago would have been quite satisfied to sweep up a casting or a core—necessitating the simplest of sweep boards from the patternmaker, the cost of which represented perhaps a ratio of 1 to 8 or, say, 1 to 10 to the cost of moulding—now call for full patterns, resulting in a change in the ratio to nearer 1 to 1 patternmaker's to moulders' time. Similarly, at the other end of the scale there are highly-mechanized mass-production foundries producing small castings entirely by unskilled labour by virtue of the introduction of high-grade accurately and completely machined metal patterns mounted on machine plates. These ensure, with the assistance of a good moulding machine, a perfect mould every time at rates of up to 400 and 500 boxes per shift—a phase of development carried to such a pitch that the human element has been almost entirely eliminated by the development of automatic moulding machines. With this all-round demand for more production resulting in more responsibility being placed on the patternshop, one finds many patternmakers now partly encompassing the field of the high-class toolmaker, in marking-off patterns and coreboxes with the use of vernier height gauges, using the metal milling machines and sometimes even being called upon to operate metal-turning lathes. The different types of pattern equipment are now almost legion and it should be remembered that this title can cover everything given to the moulder to produce a casting from (including a broken casting patched up to make one casting off), a long list ending in fully-machined metal pattern equipment. Here one would expect also coreboxes to be steel faced and fitted with blowing bushes and air vents accompanied by core scraping jigs, assembly and transfer jigs suitable for real mass-production work.

Groups Selected

It is not intended to cover this vast field, but to divide the chosen examples into six sections of equipment, *viz.*:—(1) Loose, yellow-pine; (2) loose, mahogany; (3) plated, mahogany; (4) loose, filed and

* A Paper read before the Lancashire branch of the Institute of British Foundrymen.

FIG. 1.—*Patternmaker using a vernier height gauge for marking datum lines on a flywheel-housing casting.*

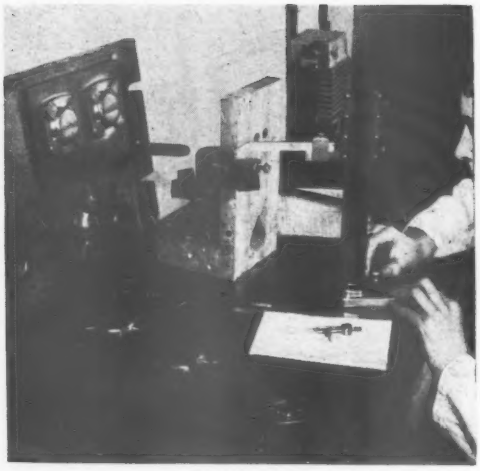


FIG. 2.—*Checking a sectioned rotor casting. In the background (left) is a cast-iron bolster plate recessed to take four section patternplates which can be interchangeable.*

scraped metal; (5) plated, filed and scraped metal, and (6) plated and fully-machined metal. The master patternshop with which the Author is associated manufactures patterns in all these categories, but specializes in the last-mentioned type. This is generally accepted to be the class demanding the maximum knowledge and skill of the craftsman patternmaker blended with a good grasp of the toolmakers' art and also a knowledge of up-to-date methods of production in a modern mechanized foundry.

Following a similar policy to that which is widely accepted as desirable in America, the firm is very closely allied to an aluminium-alloy foundry. Thus provided are the conditions considered ideal for turning out trouble-free pattern equipment. In this connection the Report of the Brassfoundry Productivity Team which visited a section of the American

FIG. 3.—*Pattern framework for a compressor casing, size* 18 *ft.* 6 *in. by* 5 *ft.* 6 *in. by* 4 *ft.* 6 *in. overall.*

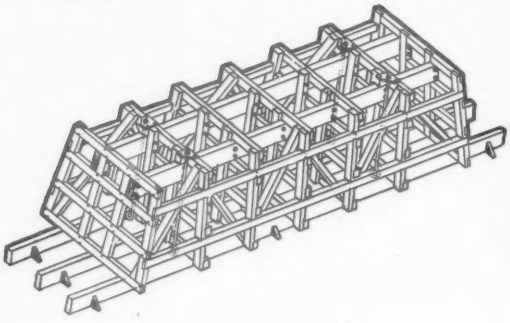


FIG. 4.—*Loading the finished bedplate pattern for the compressor, the vertical lagging with* $\frac{1}{16}$*-in. spacing and the loose-pieces are noteworthy.*

foundries in 1950 is well worth close study. The Author's firm goes a stage further than the Americans in giving service and, by arrangement, produces moulds, cores and sample castings from the pattern equipment before despatch. The production of cores and moulds provides a guarantee for the elimination of bad draws, improperly-fitting cores in print locations and "crushes"; the casting is also checked for mismatch, "flash" or inadequate venting. The trial casting is marked up to the drawing and sectioned as the final stage in "proving" the complete pattern equipment. The master patternmaker does all the marking of sample castings with the use of the vernier height gauge, and it may be of interest to point out that when marking an aluminium sample casting intended for

FIG. 5.—*Distance piece and casing pattern for the compressor, loaded for despatch.*

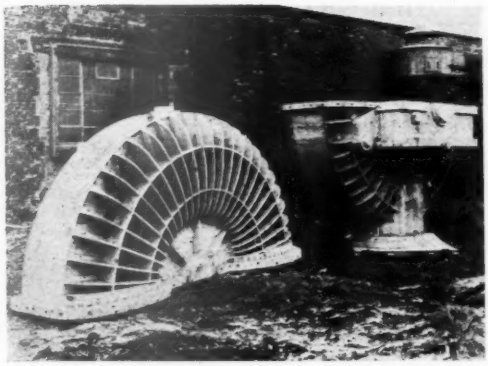


FIG. 6.—*Top and bottom halves of yellow-pine pattern equipment for a steam-turbine casting.*

casting in iron, an allowance of 0.002 in. is made; this is approximately the difference between aluminium and iron contraction.

Fig. 1 shows a patternmaker marking one of the datum lines on a flywheel-housing casting. In the background is the moulded-out drag plate, which is an aluminium shell casting set into a machined cast-iron plate; note that the same datum lines are used for checking section points. Also shown is an end view of the top-part pattern used for this job. Accessories used for checking the sample casting include thickness callipers, mathematical tables and an eye-glass to assist in setting the vernier gauge. Fig. 2 shows the marking up of a small rotor casting after sectioning; in the background (left) is a bolster plate, which consists of a cast-iron frame recessed to take four separate plates, one of which protrudes from the bolster to illustrate this feature. This a very satisfactory method, as four separate jobs can be moulded in the same box, or two of the quarter segments can be removed and a half plate with a larger job put in their place.

FIG. 7.—*Electrical connection-box casting, the patterns for which were made from mahogany with fillets carved from the solid.*

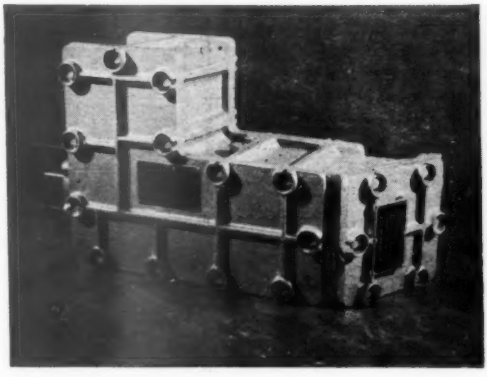


FIG. 8.—*D.L.B. body mahogany pattern equipment. This job was made in halves and the corebox in two parts.*

Comparing this sort of service to founders with the normally accepted method of purchasing a pattern, which has undergone only a simple dimensional check, shows clearly the removal of all doubt in the mind of the purchaser. Ample evidence is provided to convince the most sceptical buyer that the equipment he has purchased is dimensionally correct and also that it produces a casting of high quality, and accuracy. Frequently, patterns proved in this

FIG. 9.—*Pattern and corebox for a flame-arrester casting in aluminium which enters into the "plated" mahogany category.*

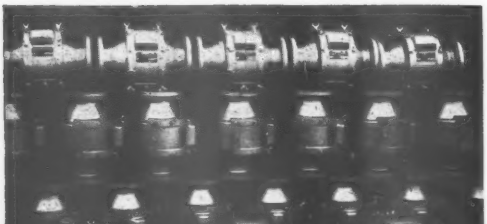


FIG. 10.—*Group of flame-arrester castings. They are used to prevent spread of fire in oil pipe lines.*

way are released for immediate production in the foundry. Where core or mould gauges, or core carriers, are involved, these are also passed through the same " proving " process before being released to the customer.

Air Compressor Casing

Of the different types of patterns manufactured, the first to be dealt with enters the loose, yellow-pine category. Fig. 3 shows a sketch of the framework of a casting pattern for a large air-compressor. It is about 18½ ft. long and 6 ft. wide at the base and stands about 5 ft. high. The sketch illustrates the way in which the frames and battens were built up on a set of level skids on the floor. The two battens ran the whole length of the job and were of 9- by 3-in. section, providing a sound skeleton for the pattern and fulfilling their purpose in keeping it very rigid. At the same time, they gave an excellent and valuable double backbone to take the full thrust of the load imposed when withdrawing the pattern from the mould. With a construction of this type there is never any difficulty in getting the pattern out of the mould in one piece and without distortion.

All the side lagging on this type of pattern is essentially of 1½-in. timber, dressed and having the grain in the direction of the pattern draw. At least a $\frac{1}{16}$-in. gap is left between the vertical lagging to allow for expansion of the timber whilst the pattern is in the sand. Four, sturdy 1-in. draw-bolts pass through boxed-up pieces and are guided and screwed into ½-in. thick steel plates anchored to the underside of the two 9- by 3-in. lateral joists referred to earlier. When more than one casting is required from this type of pattern, the job is given at least two good coats and preferably three of shellac varnish.

The job was one of a set of three patterns made for the foundry and was claimed to be for the largest air compressor ever made in Europe. Fig. 4 shows the finished pattern for the bedplate being loaded on to a lorry for despatch. The vertical lagging and loose-pieces dowelled on are noteworthy. Fig. 5 shows the distance piece and casing pattern for the same job.

Steam-turbine Casing

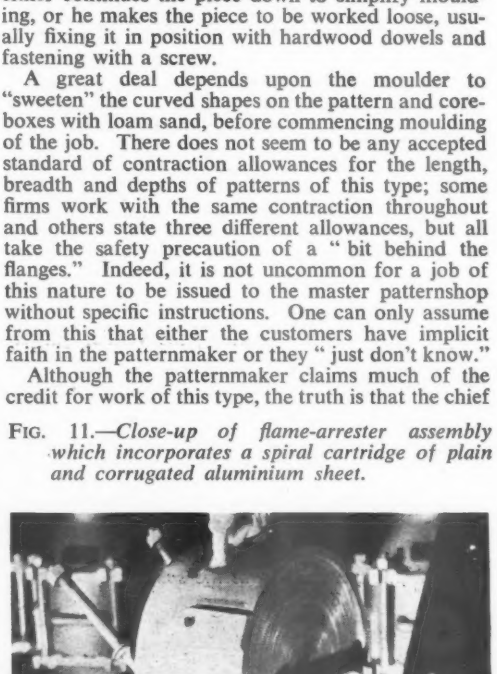
A rather different type of loose, yellow-pine pattern equipment (for a steam-turbine casing) is shown in Fig. 6, which gives a view of both top and bottom halves of the casing patterns, illustrating the typical construction of jobs of this type, the volute shape both on the pattern and in the coreboxes being formed by " star pieces," as they are known in the North of England. In the Glasgow area they are known as " heilanmen " for some obscure reason.

When engaged on this class of work, the patternmaker is given a certain amount of discrimination as regards dimensions and shapes; for instance, he knows from experience to allow excess behind the flanges and on the diameters of bosses. Also, he is not greatly concerned about retaining drawing shapes and where they would necessitate loose-pieces he either continues the piece down to simplify moulding, or he makes the piece to be worked loose, usually fixing it in position with hardwood dowels and fastening with a screw.

A great deal depends upon the moulder to "sweeten" the curved shapes on the pattern and corebox with loam sand, before commencing moulding of the job. There does not seem to be any accepted standard of contraction allowances for the length, breadth and depths of patterns of this type; some firms work with the same contraction throughout and others state three different allowances, but all take the safety precaution of a " bit behind the flanges." Indeed, it is not uncommon for a job of this nature to be issued to the master patternshop without specific instructions. One can only assume from this that either the customers have implicit faith in the patternmaker or they " just don't know."

Although the patternmaker claims much of the credit for work of this type, the truth is that the chief

FIG. 11.—*Close-up of flame-arrester assembly which incorporates a spiral cartridge of plain and corrugated aluminium sheet.*



architect in this field is the moulder. It is here he performs near miracles with mould joints, balancing large heavy cores on chaplets and scheming out and cutting awkward drawbacks.

Exhaust-vent Hood

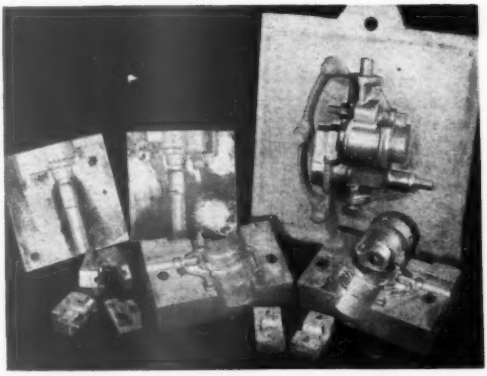
Proceeding now to the next class, namely loose, mahogany pattern equipment, a casting [exhibited] of an exhaust-vent hood can be cited. The shape and design of this job has every appearance of being a good illustration of the age-old maxim that " there are more ways than one of doing any job." From first appearances, it would seem that the best method to make this pattern would be to joint it along the main centre-line and thus ensure a flat joint for ramming up, but in this case, a solid one-piece mahogany pattern, which necessitated the small flange being worked " loose," was decided upon.

A plaster oddside, to simplify the mould jointing, was supplied with the pattern to the foundry. The advantages of this method of moulding were:—A good seating for the core; easy access to check metal thickness when the core was in position, and reasonable freedom from danger of crushing when closing the mould, because of the radial shape of the body. These were the deciding factors which influenced the adoption of this particular design, which although not very popular with the foundry at first has justified itself in continuous operation.

Westool Box

The next example which is also in the loose, mahogany category, is an electrical-connection box, Fig. 7. The pattern equipment is of first-class mahogany throughout, with fillets all carved from the solid timber. It was made to mould in three parts, the top flange being metal dowelled into place to be worked " loose." The main body was boxed up with the outside lagging having the grain running in the direction of the pattern draw. The flanges were pieced up and were provided with end stiffening pieces to prevent them from twisting. As can

FIG. 12.—*Cylinder pattern equipment for pneumatic-drill castings—comprising mounted and partly-machined components.*



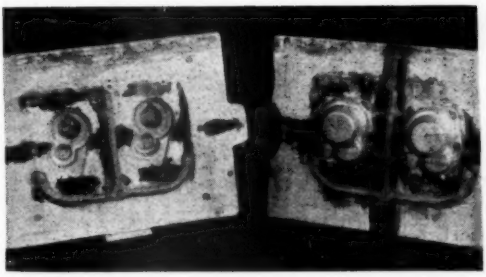


FIG. 13.—*Pattern for the pneumatic drill. In this case two patterns were mounted on plates.*

be seen from the illustration, it is a fairly substantially designed casting, well ribbed up all round. The fillets on the job were purposely increased because of the tendency of the special alloy in which they were cast, to draw and crack at points where changes of section occurred. The covers, also shown, were treated in the same manner—being cast in the same alloy. The completed unit was water tested by the patternmaking firm to a pressure of 100 lb. per sq. in. before delivery to the customer.

D.L.B. Body

Fig. 8 shows a first-class mahogany pattern in halves and the corebox made in two separate parts. This is a good example of a wise expenditure on pattern equipment, as the job, although not in continuous use, is used occasionally for small batches of castings. Such procedure entails a fair length of time in storage and, as is well known, shrinkage and distortion can occur during such periods. The general metal thickness of the casting is $\frac{5}{16}$ in. and up to date there have been 40 to 50 castings taken from the equipment. It is true to say that it is good enough for further quantities in the future, surely a tribute to the craftsmanship, care and thought put into both pattern and coreboxes by the man constructing the job.

" Plated " Mahogany Patterns

Turning now to plate-mounted mahogany pattern equipment, Fig. 9 shows the pattern and corebox for a 4-in. flame-arrester aluminium casting. As can be seen, it is a valve type of casting and is used extensively in oil-fields throughout the world. Only one half-pattern was made in this instance, and when mounting it on the plate, care was taken to ensure that the pattern was central about the plate pins to enable the use of one plate for both cope and drag moulds. It was advantageous that the nature of the core-prints enabled the patternmaker to do this without special provision for core clearance on the top part. One half-corebox was sufficient, as this was also reversible.

The pattern was built up in pieces of solid mahogany with the grain running across the main centre-line, and to give rigidity, a mahogany bar

FIG. 14.—*Sample cylinder casting for the drill, being marked up by the patternmaker.*

2½ by 1¼ in. was checked-in lengthwise. The core-box shape was cut in the same manner as the pattern and all was encased in a stout yellow-pine frame. The loose facings shown were made of aluminium and dovetailed into place for working "loose."

Fig. 10 shows a number of assembled and completed flame-arrester units, which as their title suggests, are used in oil pipelines, with the purpose of preventing a fire from spreading from one section to another. This is done by means of the tube bank shell which can be seen being loaded into the body casting in Fig. 11. The tube bank shell is comprised of alternative sheets of plain and corrugated aluminium, which is wound round a centre pin of Dural rod, encased in the aluminium tubular casting.

Support-rod Bracket

[Continuing with another example in the plate-mounted mahogany pattern category, the Author exhibited a sample casting of a support-rod bracket.]

FIG. 15.—*Fully machined metal pattern tackle for a manhole vent fan* (*see Fig.* 16).

FIG. 16.—*Design of the manhole vent fan casting.*

This pattern is of the solid one-piece variety, with the exception of a loose boss which is made in aluminium with a good dovetail running its full depth. The main body of the pattern is of 1-in. thick mahogany laminations and advantage was taken of this to ensure correct section shapes on the joints. The laminations were fixed together first and then the dovetail for the loose-piece was cut; from the aluminium boss, the profile was marked and cut to shape. The corebox was given the same treatment as regards the laminations, and thus it was simple to draw inside and outside shapes to give the required metal thickness. The internal shape was then encased in a yellow-pine frame and loose-pieces added to finish it off.

Loose, Partly-machined and Scraped Patterns

Gauze Cage and Hood.

As an example of loose, filed and scraped metal patterns a gauze cage and hood [exhibited] is one of a wide range one patternmaking firm produces completely assembled for a very well-known concern. They make the patterns and castings, machine and assemble the complete unit. The hood is a metal shell pattern, which was made from a plaster shell master. The pattern casting was skimmed up in the turning lathe and thus a good working pattern was ensured. The gauze cage castings were made from a jointed metal pattern; it consists merely of two circular rings separated by four perpendicular arms. The first problem was whether completely to mould the job or to core-out between the arms. By using cores, the job would have been a straightforward one-piece pattern, but the resulting castings would have possessed marks showing the core joints. The increased cost caused by the introduction of cores, also decided the patternmakers to make this as a three-part moulding job.

When making the pattern, the two rings were turned up in the metal lathe. The heavier ring was recessed to take the arms which were Allen-screwed and dowelled into position; this part was then re-chucked and skimmed up both inside and out. The profiles of the arms were then filed to shape and finished. In moulding the job, the loose (drag) ring is bedded into a turn-over board recessed to take the fillet pads. After ramming up it is turned over and remainder of pattern is rammed in middle part; the top part carries the downgate and the risers.

Cylinder, Cap and Head for Pneumatic Drill

Coming now to a costlier type of pattern equipment, namely plate-mounted and partly machined and scraped metal tackle, the three sets of pattern equipment—cylinder, cap and cylinder head—shown in Fig. 12 all enter this category. The cylinder pattern—in halves—was machined on the joint, but filed and scraped to size elsewhere; this was possible by the use of a first-class master pattern. The corebox "masters" were made in the same way, only the straightforward faces and forms being machined to size. The cap pattern (Fig. 13) was also a scraped and filed-all-over job, in this instance two patterns being plated. No cores were used, as the inside was formed by mould.

The cylinder-head pattern was a different proposition, there being the intricate coring of the inside to contend with. The pattern itself was a plain "flatback" and all the cores were assembled together as a complete unit before being placed in the mould. One feature common to these three jobs is that each has inserts cast in position; this, of course, brings extra hazards to those normally encountered when producing castings of this nature.

Fig. 14 shows a sample casting of the cylinder being marked up to the drawing by the patternmaker, as the final stage of the inspection. Note the method of attaching the casting to the cube, by a bolt and setting in position with adjustable jacks. In this position, the job can be marked completely before removing from the block.

Fully-machined "Plated" Patterns

Manhole Vent Fan

Proceeding now to the first of the final category of patterns, that of the fully-machined and "plated" equipment, Fig. 15 shows the full tackle for a manhole vent fan. Here is shown the pattern, which is in two parts, cope and drag, and one corebox. Fig. 16 serves to give the general design of the fan. The original equipment for this job as supplied by the customer was made in yellow pine and as the tackle deteriorated, so did the castings made from it. For this reason, instructions were given for the equipment to be replaced. The original design of the casing as made in the yellow-pine equipment necessitated loose-pieces, but permission was obtained for an alteration which eliminated the overhanging flange.

The master patterns were all made with suitable machining allowances for turning in the lathe, the finished shell thickness being $\frac{5}{16}$ in.—a reasonable metal section to confer both for lightness and strength. The corebox was made in three sections which were dowelled together before turning; in actual use they are held together by a slip ring which works on a slow taper. The three webs are checked through this centre boss and after the core is made, they draw back into the boss cavity. This is another example of an extra outlay on pattern equipment paying for itself by giving a cleaner and more accurate run of castings over a long period. This improved equipment reduced the overall direct moulding cost by 38½ per cent.

(To be continued)

Thos. W. Ward Chairmen

It is good news that Mr. George Wood will continue to play an active part in the affairs of his company after he relinquishes the chairmanship of Thos. W. Ward, Limited, at the end of the year. He will remain a director of the company, and as announced previously, in recognition of his long service with the firm, he has been appointed vice-president. Mr. Wood joined Thos. W. Ward's staff as long ago as 1897, and during a notable career he has seen the company grow from a staff, excluding workmen, of less than 100 to approximately 1,000 today, and the business from a turnover of approximately £500,000 to £22,500,000 per annum, with an additional expansion of the trade of 24 subsidiary companies turning over £10,500,000.

Mr. Wood's successor as chairman of Thos. W. Ward, Limited, Mr. Harold W. Secker, joined the firm as a lad. He became a local director in 1936, a full director two years later, assistant managing director in 1944, and, since 1950, has been joint managing director.

Mr. Secker has interests which extend far beyond the bounds of his everyday business. Not only is he interested in the Yorkshire Scrap Iron, Steel and Metals Association, of which he has been president on two occasions, but he has filled practically every office in the National Federation of Scrap Iron, Steel and Metal Merchants, of which he was president in 1948-49. He is also chairman of the employers' side of the joint Conciliation Committee for the Scrap Iron and Steel Industry.

Forty Years Ago

The January, 1914, issue of the *Foundry Trade Journal and Patternmaker* opens with a description of the Rennerfelt furnace. What a mine of information these issues of forty or fifty years ago afford to the historian of the electric furnace. A paper by Mr. A. R. Bartlett dealt very interestingly with snap-flask machine moulding. It was evident that these old timers knew the essentials of the subject but failed to realize the importance of mechanical handling. Mr. C. Heggie, another old timer, has an article on plaster patterns and details the results of personal experiments. It is interesting to note that an attempt was made to form a Foundry Traders' Association with an exhibition policy as its foundation. "Trade Talk" announced that the offices of the National Light Castings Association had moved. Amongst new companies registered appears the name of Shaw's Willenhall, Limited, and John McNeil & Company, Limited.

C. & G. Insignia Award

When the City and Guilds of London Institute created its Insignia Award in technology, the action was lauded in this JOURNAL, as it was believed that a man who, having practice as the basis of his training, spends his evenings in graduated study and thereby receives the full technological certificate, is of the type that makes good in life. Such men are worthy of recognition by an esteemed educational authority. Obviously, a thesis is required to be submitted. The scheme, which is now just a year old, has reached the stage where a committee is examining the individual cases—assessing each as an entity. The Award (the C.G.I.A.) is one to be coveted and readers who think they are eligible should ask for details from the director, Department of Technology (I.A.), City and Guilds of London Institute, 31, Brechin Place, South Kensington, London, S.W.7.

G

Correspondence

DEGASSING OF ALUMINIUM ALLOYS

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—Reading through the report of the discussion on the films "New Methods for Old" in the JOURNAL of December 3, 1953, I was particularly interested in the few paragraphs on the degassing of aluminium alloys. As Mr. G. C. Price remarked, though much work has been devoted to this problem no definite formula has so far been given to the aluminium-alloy founder that will enable him to obtain gas-free metal every time. The writer would like to describe a method which has been in use in International Alloys' laboratories for a number of years and has been successfully applied to most aluminium casting alloys, both for small melts of 5 to 10 lb. for the production of test-bars for "release" purposes, and for larger melts in foundry production:—

Heat the metal to a temperature in the range of 690 to 730 deg. C., depending on the type of furnace or size of melt. Turn off the heat and allow the residual heat of the furnace to raise the temperature of the metal to 760 ± 10 deg. C. Stir the metal carefully, gently scraping the walls of the crucible to bring up any dross, etc., and skim. Then by means of a dry, heated, die-coated plunger apply the following weights of a hexachlorethane degasser either pure or mixed with a normal aluminium flux.

Weight of Melt	*Weight of Degasser*
lb.	oz.
1,000	4.0
500	3.0
200 to 100	2.0
100 to 20	1.0
Below 20	1.0 per cent.

During the application of the degasser, move the plunger around the bottom of the crucible and occasionally also up and down, especially when the reaction is subsiding. When all reaction has ceased, skim the metal and allow it to stand for 20 to 30 min. Skim occasionally during standing.

If a pouring temperature higher than 710 deg C. is required, either of the following two methods can be used:—

1. Allow the melts to cool to 700 deg. C. or lower during the standing time of 20 to 30 min. and then heat up quickly to the casting temperature. (This procedure applies only to crucible and bale-out furnaces where the flame gases have little or no direct contact with the metal.) If this method is carried out as described, little gas pick-up will occur. This has been confirmed, as well as absence of gas porosity in the castings, by a considerable number of checks using the reduced-pressure test.

2. Allow the melts to cool only to the casting temperature required, by keeping the crucible in a holding furnace for part of all of the standing time.

Though we find the mixture of hexachlorethane and flux in powder form more effective, tablets of pure hexachlorethane are used for large melts because they are more convenient for handling. The powder is well wrapped in aluminium foil for plunging.

It is appreciated, of course, that the method will not serve for all aluminium alloys, but it has been used for many years on some of the more popular foundry alloys, which cover over 75 per cent. of the present aluminium foundry production. For the high-silicon alloys such as LM-6 and 9, a special procedure is necessary, as treatment with chlorine-containing degassers would remove the sodium which is necessary for the modification treatment. Degassing as described causes a very slight but practically unimportant loss of magnesium in alloys having magnesium contents up to 1.5 per cent., provided the degassing temperature is not higher than that quoted earlier. In alloys with higher magnesium content, the amount of magnesium loss by this treatment is scarcely noticeable.

Degassing by nitrogen and chlorine was tried for comparison several years ago, but these methods were found to be no better than the simple degassing method described, which also has the added advantage that no cylinders of gas or elaborate fume hoods are necessary. The well-known method of introducing a grain-refining preparation combined with degassing can also be carried out if desirable.

The success of any degassing process is more dependent on choice of the correct procedure than on the degassing agent used. Important factors in the procedure are (1) time and temperature during the standing period. The best degassing effect is obtained at a low standing temperature and long standing time. (2) During and after the treatment, gas pick-up can be caused by plungers, skimmers and pouring ladles which are not completely dry, *i.e.* these items should be dried, prior to use, at a red heat.—Yours, etc.,

for INTERNATIONAL ALLOYS, LIMITED,
S. J. WILLIAMS,
Metallurgist.

January 1, 1954.

Lower Prices for Middle-east Market

In Middle East markets, price is the main consideration when importers are placing orders for foreign goods. British manufacturers, who have had the market to themselves for so long, tend to be beaten in many products by countries which can produce more cheaply. Quality alone will not sell, and to keep a footing in what is already a useful market and one which will steadily expand, Britain's prices will have to be lowered. These were the comments expressed by Sir Edward Benthall, leader of a nine-member trade mission to the Middle East, on his return to London.

During its five-week visit to the region the mission visited Iraq, Kuwait, Lebanon, Syria, and Arabia. It was successful in establishing good relationships. More than one observer has commented that the visit has reawakened interest in "the somewhat flagging prestige of Britain in the Middle East." It has become apparent to the countries visited that the U.K. is interested. British business must now endeavour to develop the market as quickly as possible.

Mond Nickel Fellowships, 1953

The Mond Nickel Fellowships Committee announces the following awards for 1953 to cover study in this country, on the Continent, in the U.S.A. and Canada:—Mr. J. E. Benson (Metropolitan-Vickers Electrical Company, Limited, Manchester), to study the technique and interpretation of results of non-destructive testing of metal components; Mr. K. Blackburn (Dorman, Long & Company, Limited, Redcar), to study hot-metal basic-open-hearth practice, with particular reference to mixer furnace operation, refractories, instrumentation and "pit"-side practice; and Mr. N. B. Pratt (Broken Hill Proprietary Company, Limited, Newcastle, N.S.W.), to study the technical and economic aspects of recent advances in the erection and operation of integrated iron and steel works.

Shell Moulding of Cylinder Castings

Discussion of Mr. A. Emmerson's Paper

At one of the largest meetings the London branch of the Institute of British Foundrymen has ever known, Mr. Emmerson's Paper was received with great enthusiasm and questions were showered upon him. This report, necessarily somewhat condensed, picks out the salient features from the proceedings, such as: incidence of bursting; gas evolution; porosity; reinforcement and shell design; backing; the "D"-process; cores sand/resin formulation; distortion; running principles and economics.

At a meeting of the Institute of British Foundrymen, London branch, held at the Waldorf Hotel, the branch president, MR. B. LEVY, from the Chair, introduced Mr. A. Emmerson, general manager of Macmillan's Foundry, to give his Paper "Shell Moulding of Cylinder Castings."*

Opening the discussion which followed the Paper, MR. MATTHEWS said he would like to know the percentage of wasters that had been experienced and what reclamation of shells had been feasible—if that was indeed possible.

MR. EMMERSON asked when the speaker spoke of "wasters" did he mean wasters due to shell bursting, or was he referring to machine-shop scrap.

THE CHAIRMAN said he thought that Mr. Matthews was really thinking of scrap due to shells bursting.

MR. EMMERSON explained that some days they might put from 150 to 200 moulds down on the floor and have only one burst. Another day they might get a rather high percentage, but then they would generally find that the human element had crept in and the shells had not had a sufficient time in the dump box, so that there was a thin section somewhere; the metal found that weakness and burst out. Burning away of the sand as had been expected was not encountered; it went in one "go" and burst the mould.

Of course like most foundrymen they tried to go further and having made successfully a casting of 35 lb. they tried to move on to 50 lb. In such cases they tried a couple of moulds out and cast them very "hot" the first time. If they withstood the pressure, it was pretty certain the jobs could go into production, but when metal pressure became dangerous, backing the moulds with sand was practised.

When the Chairman spoke of reclamation, he wondered if he meant saving the sand. His firm operated a sand foundry; their job was making cylinder castings; green-sand, skin dried and so on. They could not spare much room so they had to lie the shells along the floor and the small amount of sand which was left went through the general sand system but it did not seem to harm the rest of the sand in the foundry.

Gas Evolution

MR. SHAND said the thing which worried him was how to get rid of the gas from shell moulds. Following the question by the first speaker, he would like to know what was the scrap due to the excessive evolution of gas in shell moulding. That, he thought, was a general problem. A shell mould gave off a great deal of gas; more than ordinary sand. Obviously, the time interval to permit of that gas getting away was much smaller with the shell than with a green-sand mould. Were there any problems in getting rid of such gas and its effects.

MR. EMMERSON said not the slightest trouble of that kind had been experienced.

MR. SHAND said it occurred to him that Mr. Emmerson's problem was perhaps much simpler than his own. They had been trying to make very thin castings in a shell and probably the heavier variety Mr. Emmerson had been making did not give the same trouble due to gas evolution.

MR. EMMERSON said he thought he saw what Mr. Shand was getting at. The claims made for the higher permeability of a shell mould were overdone. The permeability of a mould could go down drastically as the thickness of the mould went up. As one introduced more fine sand into the mixture to get a better surface finish so, too, the permeability went down. When he first started shell moulding he naturally expected trouble when he saw the large amount of flame generated as the mould was cast. A section was cut out of a number of moulds, and as they were cast the inside was visible. The metal lay very quietly. His firm had never experienced any gas holes in castings due to shell moulding.

Porosity Checking

MR. MATTHEWS asked if any of the castings shown had been examined by X-rays.

MR. EMMERSON said not, but it was the practice in their foundry to take a good casting each day and get it cut up into small pieces to check it for porosity. Normal production had always included a large number of Diesel cylinder-heads, both small and heavier types, and they were sent all over this country and the Continent, and it was generally found that no matter how they tried to control their metal there was always a danger of porosity in these Diesel heads. So it was made a routine practice every morning to take a casting for examination. They had found there was little or no difference in this respect between a sand casting and a shell-moulded casting, but he agreed that if there was a tendency to porosity in the sand casting it would be aggravated in the shell-moulded job. It must be remembered that the shell-moulded casting remained liquid the longer.

* Paper printed in the JOURNAL. December 3, 1953.

Shell Moulding of Cylinder Castings—Discussion

Reinforcement

MR. SHAND said Mr. Emmerson had stated there were cases when he did not back up the shell moulds with any medium whatsoever, yet there was some danger of moulds bursting. What action did he take to safeguard such moulds before casting? Did he put some sort of tie around them so that if they burst the operators were protected?

He had not been clear what Mr. Emmerson was talking about when he spoke of a rib on the back of the shell, could he explain that?

Backing

MR. EMMERSON said he thought the bursting of the moulds would be one of the problems of shell moulding with which founders would get trouble for some time, or until someone evolved a better method of supporting the mould. The Americans had tried backing with steel shot, but the cost had to be taken into consideration, and the handling equipment was expensive. His firm had used sand, but he did not like the idea of backing the mould; it cost a lot to do and that was one of the weaknesses of the process at that stage. As they accumulated experience, they knew what to expect and they did not put moulds down unsupported, unless they were sure of success, but if one mould did burst out the metal began to dribble out on to the floor. When shell moulds were put on to a roller track for pouring there had to be some means of taking care of the metal which ran out of the mould.

As to the ribbing of the mould his remarks there applied to the "D" process and he thought he could explain practically. If they took a typical C-process mould (like the one exhibited) they could be put on the floor for casting, without any danger whatever of bursting. But when it came to a second design (selecting another example from the many exhibited) then they would find there was a tendency for the metal to burst out. Using a heated pattern in the dump box of the "C" process the sand would build up evenly to the same shape as the pattern, but the danger of bursting would be where the heavy section of the casting came. Little could be done about it; ribbing over the weak spot could not easily be applied and here he was inclined to think that the "D" process would cater better for that class of work. There the principle was different, sand was being blown through the patternplate on to a contoured plate. The contoured plate, or dryer, could be shaped to give a greater thickness at local danger spots, it also could be ribbed wherever needed to provide a mould strong enough to be cast unsupported. With D-moulding of very heavy jobs, the back of the mould could be so shaped and tapered that the contour plate, suitably perforated, could be placed on again, clamped, and cast without any danger whatever of bursting.

MR. P. G. PENTZ referred to the shell-moulding process and wondered whether Mr. Emmerson would agree with him that the possibility of bursting of the shell was decreased for any given casting if the two shells were bonded with adhesive rather than clamped round the edges. His experience was that if this were done there was mating of the two parts over a much greater area, and apart from the question of bursting it did seem to reduce dimensional inaccuracy which was sometimes due to the bulging of the shell in the middle.

In the same connection, with bursting, would Mr. Emmerson say that mechanization of the process (obviously under conditions of having sufficient work to make it worth while) would eliminate many of the wasters which he had said were sometimes got due to the human element in not giving sufficient time in the dump box to form a shell of adequate thickness?

It would be interesting to many to know what dimensional tolerance it had been found possible to get across the joint line in ordinary shell moulding. On the question of permeability he wondered whether perhaps the trouble with gas referred to by another speaker was due to backing the shells with sand or something relatively non-permeable. When shell moulds were supported with sand was it dry-sand or green-sand? On the "D" process, he thought it might be interesting to founders to learn that the liquid phenolic resin mentioned would cure at 500 deg. C. for a ½-in. shell in a little over 5 min. as compared with 30 min. for the oil.

Lastly, did Mr. Emmerson agree that the technical advantages of the "C" process and the "D" process might be combined, if it were possible to blow the dry sand/resin mix in the same way and with the same equipment for contouring the back of the shell, just as when using the liquid resin or oil/sand mix in the "D" process, but curing the shell in contact with the pattern?

Dealing with these matters, MR. EMMERSON said members had seen the type of castings he had poured; some weighed 35 lb. each, which had actually been poured with just adhesive round the joint. There were various adhesive compositions available, many of them very good. His firm had actually poured those castings and some even a little larger, without any clamps, but in practice it was rather risky, for this reason:—If cheap jobs were being produced there would be something to be said for fixing up a system of clamping the moulds together with an adhesive round and an occasional loss. Their class of work, however, was relatively expensive—their value was in the core work and the time required to assemble and it was not worth risking a "scrapper" in order to save a minute or two spent on fitting clamps.

Tolerances

He agreed that tolerances were a sore point with engineers. If they took, for example, a job the size of an ash tray, providing they put the whole of the pattern in the drag or the bottom half, it was quite possible to hold the dimensions inside to one or two "thou.", but where they put the halves together, across the joint, then they could run into trouble dimensionally. It was possible with great care to hold this value to a few "thou.", but he had not made that type of casting. Experiments had proved to their satisfaction what they could do, but such was not their class of work, so they had not persevered with it.

Certain air-cooled cylinder castings (exhibited) were originally machined on the back of the flanges and of course turned on the spigot and a rough and a fine cut taken in the bore. When shell-moulding these they had started by removing the machining allowance at these points but they had still to machine the bore, although even there that had been reduced to one finishing cut. Then they had been asked by the customer to try and leave no more than $\frac{1}{64}$ in. each side to come out but they had refused. The core could be made accurate enough to do that, but the problem was to clean up such a large surface area by taking off so little and yet leave a perfect finish. Therefore, they would not recommend going to that length, but they had removed the machining on that casting down to very small allowances, and now the customer wanted to know why they did not put the drill holes in the sides !

As to permeability, they simply packed with ordinary backing sand—the sort used on their moulding system. Some old steel boxes which were no further use on moulding machines were used and a labourer rammed sand round the shell mould, but it had to be done carefully. Involved were typical problems of sand ramming—they did not want to ram too hard and they did not want soft pockets. He did not like unnecessarily packing moulds with sand although they had not found any loss of permeability or, rather, there was enough permeability left through the backing sand, for which a permeability value of 100 was specified.

Shell Cores

With regard to blowing shell moulds, if they could blow a dry C-process powder it would be " a winner," but so far results were not too encouraging. There was no doubt, however, that though shell moulding of moulds might be open to question, there was no argument about shell cores. They would beat oil-sand cores hands down. When making an ordinary-sand crank-case core for instance they first rammed the sand in the box, stripped it and stoved it; took it out of the stove and laid it down. Then it was taken up again, placed on the other half, gauged, pasted, blocked, then stoved again, and the chances were that with so much handling it would not fit. A shell core, on the other hand, they took straight out of the corebox, put it into the mould and it would fit beautifully. It was not cheap to make shell cores but if they could blow such a core as they blew ordinary cores, then the industry would be very enthusiastic about it. In experiments, he had ejected the sand into the coreboxes by using compressed air, but while they had produced many cores by that method, it was still an unsatisfactory job. If someone could solve the problem of blowing the C-process sand into the corebox, then it would really open-up enormous possibilities. Of course, on the " D " process a liquid medium was used, having a certain amount of bond like the normal type of core-blowing sand, but that was still, he thought, in the experimental stage though he hoped it would not be so for long. He could see no reason why jacket cores should not be made in this sand, thus eliminating many strengthening wires.

Local Strengthening

MR. MASTERS asked Mr. Emmerson, in connection with the " bursting-out " of shell moulds, if he had tried putting a handful of the resin mixture on the individual spot where bursting-out was being experienced, and doing this during the period between investment and curing. thus forming a thicker section over the area involved.

MR. EMMERSON replied that that had been tried but it was hard to get a handful of sand to adhere to the biscuit. They had made sheet-metal frames so that they could pour some in to support a weak point, but it was found hardly practicable.

Stripping and Pouring Procedure

MR. ELLIOTT asked if Mr. Emmerson could say if he used stripping pins. Also, did he cast his work on end or flat ?

MR. EMMERSON in reply said he still used pins, as they were easy to fit and satisfactory in use, but they were looking into other methods.

They tried as far as possible to cast jobs on end, because then they got the effect of having the runner bush formed at the same time as they made the mould. On certain castings (demonstrated), there was an advantage in casting that way for it was the best way both to run and feed the job, and at the same time to form the bush. One problem was that a rather large part of the mould face was taken up with the bush and runner-bar, and this cost money. Even if they had run it around the outside they would still have had to make an allowance for the runner-bar, and the problem then was that on the back of the mould they had an uneven surface on which to place the pouring bush.

They cast a certain cylinder-head (exhibited) on the flat. The reason for that was to get the casting sound. It looked an easy job, but the chamber core ran nearly the full length of the casting, and it was very difficult to hold the core at the correct angle and at the same time make sure that the metal at the end of the chamber was perfectly sound. Originally, the casting was made in block-type oil-sand cores and the core was held with lead. Chills were used in the core and on the mould face along with a special 3 per cent. carbon, 3 per cent. silicon iron to ensure soundness. It had been a pretty good method, but after examining the technique it was decided to shell mould the casting.

By placing a riser over the end of the chamber core, fixing a shell bush on the top, and running through a strainer core placed in the bush, they were able to cut out the use of chills and cast the job in their normal iron having 3.25 per cent. carbon, 1.8 per cent. silicon and 0.15 per cent. phosphorus. Nearly 1,000 such castings had been made in that way without any trouble with porosity or core movement.

Sand/Resin Formulation

MR. KEEBLE asked would Mr. Emmerson tell them the highest permissible moisture content of the sand

or the resin/sand mixture. Secondly, one of the photographs had shown an iron frame or grid being placed over the shell and then reinforced with a free sprinkling of sand/resin mix. Could members be told whether the grid was heated before being placed in position?

Thirdly, the percentage of resin in the mixture had been mentioned; how closely could the resin content be controlled from a technical standpoint apart from the cost factor? A slide had been shown of a cylinder-head and linked with it was the statement that for the first time the engineer was being given close tolerances. He thought that was exaggerating a little for the simple reason that the non-ferrous industry had for many years been producing many hundreds of tons per annum of gravity-die-castings to very close limits—as close as those of the shell-moulding process in grey cast iron.

Concerning the "D" process, he felt here there were even greater potentialities for the British foundry industry. Had Mr. Emmerson any information about the effect of moisture on the D-process shells from the point of view of shell "life." One of the claims for the C-process biscuit was that it could be carried in a "library" and there was no adverse effect from moisture. Could Mr. Emmerson say if the D-process bonding material was generally available?

MR. EMMERSON said with regard to moisture content, that they dried all their sand, even for the ordinary coreshop, and bought the Redhill "H" sand ready dried, delivered in paper bags.

The grid was not heated; a little of the sand/resin mixture was placed on top of the grid in one or two places, but that was merely to hold it so that when it came out of the stove it would not fall off in the dump box when reversed for second investment.

As to resin content: they had found that a core containing 3.0 per cent. or even 2.5 per cent. was quite strong and it was very free from blemishes. He admitted castings were not perfect and he was willing to learn how they could be improved, but they had found that a 3.0 per cent. resin core was quite adequate. There was no marking in the bore or on the internal surfaces of the casting where a shell core had been used. It would seem as though the higher the resin content the more liable were the castings to skin blemishes. They had made moulds with 5 per cent. resin/sand and they had worked at between 6 and 7 per cent. It would seem to work out this way: 3 per cent. mixture for an internal core, 5 per cent. on a thin casting and up to 7 or 8 per cent. on a heavy casting for the shell moulds. He had seen mention of as much as 8 or 10 per cent., but his firm would not go as high as that; cost had to be taken into consideration, so they kept down to 6 to 7 per cent. maximum.

Storage Properties

Holding up a "D" shell, Mr. Emmerson remarked that it had been lying around for three weeks and it was quite likely that it could stay around for another three months and not cause any trouble in casting—that was one of the blessings of the process. In a normal foundry, running certain jobs from a special iron, it was quite a business to make the moulds and get everything organized so that everything arrived at the right time. But if their moulds could be made and laid out on the floor and left until all was ready for them it simplified matters considerably.

As to the availability of oil, he thought the position was clear now, but there were members and guests present who could speak with more authority.

MR. MASTERS confirmed that the suitable oil was now available to anyone who wanted it for trial or production purposes.

A MEMBER asked if Mr. Emmerson had found distortion of the mould caused by the constant re-heating of the patternplates.

MR. EMMERSON said they had had that trouble when they started using a very thin patternplate. Originally, an aluminium plate had been selected for ease of handling on the dump box but, finding distortion occurred, they changed to a rather heavy plate, but kept it as thin as possible, ribbing it so that they did not get distortion. They made their own patternplates and had found that it paid to put them through an annealing stove initially and take care of distortion that way. Since following that practice they had had very little trouble.

Casting of Steel in Shells

MR. BARNARD asked Mr. Emmerson if he had had any experience of casting steel of 0.1 to about 0.4 per cent. carbon in shell moulds.

MR. EMMERSON said he was quite out of touch with the steel and non-ferrous side, but he understood that all sorts of metals had been cast in shell moulds. He believed there was some talk of carbon pick-up on the steel, but he did not know if it was serious, though he could well understand it was possible. He believed most of the stainless steels had been cast successfully.

MR. LEVY (chairman) said he did not know the particulars of Mr. Barnard's steel, but he could assure him that in his workshop there were some first-class castings of stainless steel made in shell moulds. Not only had they a beautiful finish, coming out almost with a polished skin, but they were metallurgically sound. They had been made under almost laboratory control.

MR. KEEBLE said he would make one observation following the reference to shell moulding of steel. Some restraint should be exercised with respect to stainless steel in shell moulds. There was a suspicion that, according to local conditions, there may be a carbon pick-up in the skin of the casting. Unless this higher carbon skin was removed by subsequent polishing or machining, etc., it could be the cause of service difficulty, particularly if joining to fabricated stainless-steel structures by welding was involved. Consequently, this possibility of carbon pick-up should be seriously considered when considering the shell-moulding of this material.

Running Methods

MR. BOOTH asked if Mr. Emmerson could give members any principles to be applied in deciding the method of running. He had noticed that some of the

examples appeared to be run through the top of the casting, through some sort of reservoir. When pouring from the top like that, had he found marking of the surface apparently due to turbulence? Also, when the shell was cast with the joint horizontal, was the runner bush secured to the shell?

MR. EMMERSON said that when casting in shell moulds every job had to be considered afresh on its merits, for it was an individual problem. His firm did get skin blemishes with shell castings; in some cases it was very slight; the trouble was very shallow and they had only to remove the skin and they had removed the blemish, but it could go deeper and be a serious problem. Out of many thousands of castings there had not been a single complaint about it, but the firm's inspectors noticed it, and in one or two cases the trouble had been serious. It was found they could help to eliminate the marks by bottom pouring, but in their type of casting bottom pouring created possible unsoundness of the casting.

If it was required to place a bush on top of the shell it was quite difficult because, if they took their runner bar in one case there was a round section and when casting on the horizontal square runners were preferred, for they trapped the dirt better.

In most cases all there was on the back of the mould was a small round area on which to fix the bush. A suitably-shaped pouring bush was difficult to gum on to this small area of mould but they did it in some cases using a special adhesive together with an accelerator. The joint was soundly made in a minute or two. Valve cores of cylinder-head castings made in green-sand were located in that way. This cut out the use of cylinder studs between the valve core and the jacket, these latter being always a source of danger in casting

A MEMBER asked if, in making a shell core having a 90-deg. section in it, any difficulty was found in pouring the investment to cope with the core hole?

Replying, MR. EMMERSON said the making of cores was rather a problem. He did know that some foundries had gone into production very successfully, pouring the sand into the corebox. In one of the illustrations which had been displayed a crank-case for a compressor, there was an awkward little part which they could not get the sand to enter. They adopted the expedient of using a funnel to pour the sand where they wanted it. It was an idea which might solve some difficulties.

Economics

MR. J. RUCK asked for Mr. Emmerson's comments with regard to cost when changing over from ordinary sand moulding to the shell process. He would like to know when they could expect to show a profit, taking into consideration the new outlay. How long did it take before a profit could be shown over ordinary sand casting for, say, a cylinder casting?

MR. EMMERSON said he would like to know if they had previously made their cylinders in an oil-sand mould or in a green-sand mould, and Mr Ruck said the latter was usual.

Continuing, MR. EMMERSON said he had been hoping someone would raise the question of cost; the whole of the process centred around this problem. As a foundry manager, he had made moulds by practically every available means and the shell process was just another way to him of making a mould. If it was a good way he would use it. If it was not, then he would scrap it. So far, most of the castings they had shell moulded had originally been made in oil-sand block-core moulds, especially the air-cooled type of cylinder. Here, shells were competing with a rather expensive method of moulding. Selecting a sample from those exhibited, he described it as working out 3d. cheaper than an oil-sand mould. This was roughly true of all the air-cooled cylinder moulds they produced.

On certain Diesel cylinder-heads, also, the shell mould worked out cheaper, because here again for various reasons the mould was made in oil-sand block cores, and some even assembled in a green-sand mould afterwards. It was when one came to compare a shell-moulded casting against a typical green-sand machine-moulded casting that costing is not so straightforward. Here, on the face of it, it is impossible for shell moulding to compete. However, are we not apt to think of the green-sand machine-made mould as being very cheap, forgetting the terriffic cost of the installation of a fully mechanized plant, the heavy upkeep, the high overheads, and the fact that to be economic it must run "flat-out" or not at all?

In comparison, if a shell-moulding bay were kept separate, properly equipped with a suitable machine, and a small number of producers, with the machine being worked "round the clock," the moulds cored up, clamped and just laid down for casting, it might surprise founders what an enormous output per man/hour that could be attained.

Even when the cost of the resin, sand, metal, gas and other incidentals was charged and a reasonable "overhead" was allowed, it was quite possible that a number of jobs now made on moulding machines could be shell moulded to give a superior casting and still show a reasonable profit.

Vote of Thanks

MR. PENTZ, rising to propose a vote of thanks, said it was a special honour and a privilege as a member of the relatively new Southampton section to be asked to express their thanks for so excellent a lecture. He assured Mr. Emmerson that that vote was by no means a merely formal one. They felt deeply indebted to him for several reasons. His paper had seldom if ever been surpassed; but he had done much more than give them an able and extremely interesting Paper; all would agree that he had given a great deal of additional information in the way he had answered questions and elaborated on them to give an insight into the job. This was real, practical information on the process, of the type which foundrymen had been wanting for so long. For some time, he knew, foundrymen had been saying they did not want to hear "theoretical" people talking about shell moulding. They wanted information from a foundryman who had done the job. He believed that evening was the first time that anyone who had been doing shell moulding on a practical basis had had the courage and public spiritedness to come

Shell Moulding of Cylinder Castings—Discussion

forward and give information on the results of the work done. It would have been all too easy for Mr. Emmerson, having agreed to give the Paper, to have withheld essential information for the private benefit of his own firm. Obviously, he had not done so, but had spoken with complete candour. Members owed a real debt of gratitude to Mr. Emmerson and his firm for the attitude they had taken in that matter.

MR. TALBOT, who seconded, said that apart from anything else thanks should be accorded to Mr. Emmerson because by tackling shell moulding he had shown that he had courage. He had introduced shell moulding alongside mechanized and other standard foundry practices and had proved as a foundry manager that it was a practical method, that it could compete with other standard practices and had advantages that others did not possess. That was not all—he had proved that it could pay and he had in addition given a lot of encouragement to other founders.

MR. EMMERSON, acknowledging, said that it was his first attempt at lecturing and he could assure members he had begun with a very peculiar feeling at the pit of his stomach and greatly appreciated the very sympathetic and helpful manner in which his talk had been received. He recognized there were many weaknesses in it, but one thing in which he strongly believed, being a member of the Institute of British Foundrymen, was that the more they could co-operate and the more they could exchange their ideas, the better the industry as a whole would be. Shell moulding was in its infancy, but much technical knowledge had been gained and the more they got together and discussed that knowledge the more effective it was likely to become.

Impact Testing of Flake-graphite Cast Iron

*By G. N. J. Gilbert, A.M.I.Mech.E.**

Amongst the problems of inpact testing of grey irons are the following:—

(1) Charpy resilience tests and slow transverse tests have been carried out on notched and unnotched specimens and the Charpy tests have been compared with work of rupture shown by the slow transverse test.

(2) As the dimensions of the test pieces increase, the Charpy test should be multiplied by a coefficient, which varies between the square and the cube of the increase in dimensional size.

(3) Various grey irons have been tested for resilience at different temperatures and there would seem to exist an interval of the transition temperature.

(4) The mechanism of the starting and the development of cracks has been investigated and the rôle of a notch when impact testing cast iron has had consideration.

(5) Test pieces for impact testing of various sizes machined from bars of different dimensions, have been broken and the optimum dimensions for test pieces determined.

(6) The meaning and the interest of impact testing of grey iron has received consideration and the Charpy machine seems the most suitable for fulfilling them.

* Résumé of a Paper presented to the Paris International Conference. The Author is on the staff of the British Cast Iron Research Association.

A DRAFT British Standard (CR (SFE) 8339) for steam-heated cooking equipment has now been issued for technical comment from industry. Views should be addressed to the committee secretary, Mrs. M. S. Thompson, at the British Standards Institution, 2, Park Lane, London, W.1, not later than February 11.

"Loose Pieces"

By "Tramp"

Due to the design of certain castings, it is necessary to use "loose pieces" on the pattern to enable it to be extracted from the mould. For production work, "loose pieces" should be avoided whenever possible, either by securing approval for a modification of design —which is not always practicable—or by blocking out and using a core. When, however, it is essential for "loose pieces" to be employed, it is necessary to ensure that they possess generous taper to allow of their easy withdrawal from the mould. Care, too, should be taken that there is sufficient room in the mould cavity for their reception, as occasionally this point is overlooked and the "loose piece" cannot be extracted as anticipated.

The positioning of "loose pieces" can be accomplished either by skewers or dovetails, the latter being preferable; patternmakers' brads should never be used for this purpose. The best method, where feasible, is to cut a portion out of the main body of the pattern and fit the "loose piece" in position and then carve a fillet around it.

Some designs are so awkward from the foundry point of view that no matter where the pattern is split, "loose pieces" are necessary. In such cases the patternmaker must decide on the best way to make the job and as a general rule the "loose piece" should be the least important part of the pattern. By this it is meant that if the choice of the mould joint depended on either making as a "loose piece" (*a*) a part of an important flange, or (*b*) a boss, the latter should be adopted, as "loose pieces" forming portions of flanges are apt to be malformed, for invariably the amount to be drawn in is greatly in excess of that necessary for a boss.

A little more thought on the subject of "loose pieces" by the patternmaker could often result in a far better casting being produced.

MORE THAN 1,000 EMPLOYEES and their friends attended the annual social of Qualcast, Limited, Derby, which was held at the King's Hall, Derby, on January 1, 1954. Long service awards were made to a number of employees, and a television set was presented by Mr. V. Jobson, chairman and managing director, to Mr. S. Tongue, who has completed 60 years' service with the firm.

Developments in Vitreous Enamelling on Steel in the United States*

By Ernest M. Hommel

In reviewing the history of the porcelain-enamel industry over the past twenty years, one feature stands out which has contributed more to the increased use and improved serviceability of porcelain enamel items than any other one single thing. This feature is the reduction in thickness of porcelain-enamel coatings which has evolved over the commercial life of the industry. It should be emphasized that there have been a number of other developments which have made this reduction in thickness possible. High-opacity frits have made thick coatings unnecessary for producing adequate coverage. Lower-firing enamels, both ground-coat and finish-coat, have resulted in less warpage of steel structures. Improved methods of handling materials in the enamelling plants brought about by mechanization and continuous firing have added appreciably to production of quality ware at reduced thickness of coating. The reduction in coating thickness afforded by the improvements in direct application of a finish-coat to steel is obviously an important step in the direction of increased serviceability and acceptance of enamelled items, as well as wider usage.

DIRECT-WHITE APPLICATION

I—Eckel-Romine Process

United States Patent No. 2,455,331 issued to Joseph C. Eckel and Hugh E. Romine relates to the art of enamelling and, in particular, to the coating of iron or steel articles with a finish layer of enamel, particularly white or light-coloured vitreous enamel applied directly thereto without the application of a dark ground-coat as required by conventional enamelling practice.

Prior to this invention, it has been impossible to enamel metal articles with a finish layer of enamel by applying a single coat of frit directly to the base metal and firing it, because of the development of bubbles, pits, or specks in the surface of the enamel. Neidringhaus in Patent 200,626 disclosed a method of expelling the carbon from the base metal before coating with frit, by heating it to a white heat in the presence of lime; but this method has not achieved any commercial acceptance, probably because the treatment described does not eliminate the iron carbide in the surface of the metal. Kautz in Patent 2,099,340 describes the production of a surface layer of substantially pure iron on the formed article by oxidizing it and then reducing the oxide. It is believed that the defect of this process is that it produces a coarse surface which traps the hydrates contained in the frit, preventing the elimination of the water of crystallization therefrom in the drying, with the result that water vapour is evolved on firing which is injurious to the surface of the enamel.

Badger observed that the removal of part of the surface carbon from a piece of high-carbon steel permitted it to be successfully coated with "ordinary ground-coat enamel" after it was heated in a hydrogen atmosphere to a temperature from 800 to 805 deg. C. Badger, however, did not deal at all with the problem of applying finish enamels such as the white enamel used for refrigerators, bathroom fixtures and the like.

In the preferred practice as disclosed by Eckel and Romine, a sheet or plate of low-carbon steel or iron enamelling stock, *i.e.*, steel (either open-hearth, Bessemer or electric-furnace steel) containing from 0.010 to 0.25 per cent. carbon, is formed into the shape of the desired finished article. The article is then cleaned and given an acid pickle and a nickel-sulphate dip. The carbon from the surfaces of the formed article is removed by heating it to a temperature of 1,100 deg. F. or above in a decarburizing atmosphere and maintaining it at such temperature for a substantial period, *i.e.*, from three or 30 min. After cooling the article substantially to atmospheric temperature, a layer of finish-coat vitreous-enamel frit is applied directly to the base metal and heated to a temperature sufficient to cause fusion of the frit and formation of a smooth continuous enamel layer.

Advantages Attained

The advantages attained by this process reside in the fact that the enamel layer has excellent adherence to the base metal. In addition, the removal of surface carbides appears to improve the resistance of the ware to sagging under the temperature of the enamelling furnace. Warping of the ware is also reduced or eliminated. This appears to result from the relief of warping stress afforded by the heating of the ware for eliminating carbides from the surface. A further advantage is that the total thickness of enamel applied by this process is less than that applied in the conventional practice of using ground-coat and finish-coat. As a result, ware enamelled with one finish-coat is more resistant to chipping.

The preparation of the metal for the direct application of a finish-coat is very much the same as that used in standard enamelling practice. It is important to obtain a good etch on the metal, and this is accomplished by using a 20 per cent. solution of nitric acid at room temperature immediately preceding standard hot sulphuric-acid pickling. The time of immersion in the nitric acid varies from one to three minutes, depending upon the difficulty of etching the particular metal in use.

* Paper presented at the annual general meeting of the Institute of Vitreous Enamellers. The Author is managing director, O. Hommel Company (U.S.A.).

A lower concentration of acid may be employed along with longer immersion time. It is important, also, to have a good nickel-dip treatment with the objective of obtaining a nickel deposition of about 0.08 to 0.1 grammes per sq. ft. About 10 min. immersion time in a standard nickel-dip tank is usually sufficient to obtain the desired nickel deposition. It has also been found desirable to employ a weak neutralizer solution following the standard neutralizer in order to eliminate the possibility of excessive neutralizer salts remaining on the metal surface.

When the metal is to be decarburized, the decarburizing furnace is maintained at a temperature from 1,400 to 1,500 deg. F. The chain speed is adjusted to a rate which will result in a residence time from five to 10 min. for the ware going through the furnace. The recommended furnace atmosphere is as follows:—

Hydrogen ..	12 per cent.
Carbon monoxide	10 per cent.
Carbon dioxide..	5 per cent.
Water vapour ..	Equivalent to a dew point of 85 deg. F.
Balance	Nitrogen.

A frit which is being most successfully used in conjunction with the Eckel process is the O. Hommel Company No. 968 Tite-Wite. A typical milling formula is represented by the following mill additions:—

100 OHCO A. R. Tite-Wite frit 968.
3¾ OHCO powdered clay 528.
¼ Potassium carbonate.
¼ Sodium aluminate.
¼ Bentonite.
1 Compound 1A-4574.
1/16 Gum tragacanth.
40 Water.
¼ Urea (after milling).

The specific gravity after milling is adjusted to 1.72 and the frit is ground to a fineness of 0 to 1 gm. on a 200-mesh screen. The enamel is applied at 30 gm. dry weight per sq. ft. and fired at 1,500 deg. F. for 4 min.

II—Ferro-Republic Direct-application Process

The Ferro-Republic direct-application process is a metal-treatment process which permits the application of a variety of commercial finish coats to steel. No special enamel compositions or special mill additions are required. The metal treatment is done in the enamel plant in conjunction with metal cleaning and pickling equipment; however, several additional steps are performed which require equipment not normally present in conventional pickling layouts. The metal treatment is done after all forming and metal operations have been completed.

The process is applicable to all mild steel, but has the same limitations and is subject to the same variations in steel quality as conventional enamel processes.

The process consists of two essential steps beyond those required for proper cleaning of the metal. These are: (1) A pickling step to get a "deep etch" on the ware. This is accomplished by pickling in nitric acid. (2) A nickel deposition step wherein nickel is deposited by chemical reduction rather than galvanic displacement as in conventional nickel-dip practice. It is claimed that a more continuous nickel layer is obtained by this method than can be obtained by galvanic means. Other steps such as rinsing and drying are also included.

Operating Steps

The operating steps include only those beyond the ones necessary for cleaning.

(1) *Special pickle.*—The special pickling solution consists of 20 per cent. by volume of nitric acid and is operated at room temperature. The temperature of the bath should not rise above 90 deg. F. The immersion time is approximately 1 min., although variations in the pickling behaviour of different steels may require rather wide variations in immersion time. Adequate ventilation should be provided to eliminate acid fumes.

(2) *Special pickle rinse.*—This is a flowing cold-water rinse.

(3) *Sulphuric-acid pickle.*—The pickling solution consists of 6 to 8 per cent. sulphuric acid (by weight) and is operated at 140 to 160 deg. F. This bath is used prior to the nitric-acid pickle if the ware is rusty or coated with scale, and after the special rinse in all cases to remove ferric iron salts formed during the nitric-acid pickling step. Rust and scale cannot be conveniently removed in a nitric-acid bath. The immersion time if scale and rust are to be removed will be determined by the ease of removal. When the bath is used as a rinse to remove ferric iron salts, the immersion time is of the order of 1 min.

(4) *Acid rinse.*—This is a flowing cold-water rinse maintained at a *p*H of 3.

(5) *Nickel deposition.*—The nickel deposition bath consists of the following:—

Nickel sulphate (single nickel salts)	0.4 oz. per gal.
Sodium acetate	1½ oz. per gal.
Sodium hypophosphite ..	4 oz. per gal.

The bath is operated at 130 deg. F.

The *p*H of the bath as made up will be in the neighbourhood of 5.5. As the bath is used, the *p*H will be reduced and must be adjusted upward periodically by the addition of ammonium hydroxide to maintain optimum conditions of deposition. The optimum *p*H range is 3.5 to 5.5.

The rate of nickel deposition is very critical with respect to temperature and it is suggested that the tank be equipped with temperature controls to maintain 130 deg. F., and also that it be agitated continuously with a motor-driven agitator to avoid stratification. Continuous filtering of the solution is highly recommended.

(6) *Nickel rinse.*—This is a flowing cold-water rinse.

(7) *Drier.*—Any drier which gives satisfactory drying conditions will serve the purpose.

Control Methods

There are two steps in the Ferro-Republic process which require rigorous control. They are:—

(1) The nitric-acid pickling step.

(2) The nickel-deposition step.

The other steps such as cleaning, rinsing, etc., are important and require control, but these steps are common to conventional enamel processing and need not be further discussed.

(1) *Special pickle control.*—The nitric-acid tank is made by adding one volume of nitric acid (43 deg. Baumé, which is 70 per cent. nitric acid by weight) to four volumes of water. As the bath is used, the acid concentration will decrease, and it becomes necessary to add nitric acid to bring the bath up to the proper strength. The nitric-acid bath is controlled by determining the loss of weight from a standard-size representative of the stock being used, which occurs during a definite time of immersion in the bath. A method suggested is to immerse a weighed 4-in. by 6-in. specimen of steel for a period of 45 seconds, rinse in running water, blot with a towel, dry in a suitable oven, and weigh. The weight loss per unit surface area is calculated, which should be the order of four to six grammes per sq. ft. The weight loss on pickling should be determined periodically and nitric acid added when the weight loss approaches four grammes per sq. ft. of surface area. If the desired weight loss is not obtained with 20 per cent. nitric acid in the specified time, an extension of time is suggested rather than an increase of concentration above the 20 per cent. level. Indications are that satisfactory results are obtained as long as the iron concentration is below 50 grm. per litre of solution.

(2) *Nickel deposition control.*—Nickel deposition in this process occurs by chemical reduction rather than by galvanic action as in the conventional nickel-dip process. The deposition of nickel is determined primarily by (1) the concentration of sodium hypophosphite and (2) the temperature of the bath.

The reduction of nickel at the material concentrations and temperatures given occurs only in the presence of certain metals which catalyze the reduction reaction. Iron is one of the metals which acts as a catalyst and hence lends itself readily to nickel plating by this method. At high concentrations of sodium hypophosphite and high temperatures, the reduction reaction proceeds spontaneously and precipitation of nickel occurs throughout the solution. The precipitated nickel catalyzes the reaction with the result that deposition continues at a rapid rate until the reactants are exhausted. In view of this behaviour, the operating temperature is arbitrarily set at 130 deg. F. and the sodium hypophosphite set at 0.4 oz. per gallon. Under these conditions with a *p*H of 3.5 to 5.5, approximately 0.15 gm. of nickel per sq. ft. of surface will be deposited in 5 min. on iron pickled in nitric acid in the manner described. Sodium acetate acts as a buffer to aid in maintaining proper *p*H conditions. It requires no control and need not be replenished.

III—Application of Titania-opacified Enamels Direct to Titanium Steel

This process has been in operation for five years at the Mansfield plant of the Westinghouse Electric Corporation. It is being used on range platforms fabricated from titanium steel which is produced by the Inland Steel Company. The great advantage of this process lies in the thinner coat of glass required to give the desired coverage. Along with this, warpage and chippage are overcome, and lighter gauges of steel may be used. The platforms are fabricated from 0.058- to 0.050-in. titanium steel.

The measurement of adherence of titanium enamels to titanium steel is rather novel. It is not practical to compare the adherence of enamel applied directly to steel with the adherence of a ground-coat system. For this purpose, a torsion test has been devised which measures the degree of twist a standard test panel may be given before crazing the enamel. For comparison, a normally processed white-over-ground-coat piece will stand about a 45-deg. twist on this test, while a piece processed with titanium enamel on titanium steel will stand 95 deg. or more. The comparable enamel thickness in this case being 15 mm. for the normally processed piece and 5 mm. for the titanium enamel on titanium steel with the steel thickness remaining the same. Not all titania-opacified enamels work equally well. Specially formulated frits are recommended for this work.

For the direct application of titanium enamel to titanium steel, it is imperative that the base metal be cleaned of all drawing compounds, oil, and shop dirt. The steel must be free of rust and weld scale. It must enter the nickel bath free of transfer rust and smudge. The nickel deposition must be controlled within certain limits, *i.e.*, 0.08 to 0.12 gm. per sq. ft. of surface. The steel must be transferred to the neutralizer with the least possible ferrous-sulphate coating. With the completion of the pickle cycle, the steel should appear clean and free of smudge.

These precautions are necessary in order to be able to spray the steel with enamel with no creeping or crawling and also to obtain a good bond between the steel and finish-coat.

Equipment and Processes

The equipment used at the Westinghouse plant for the pickling operation is an automatic high-lift machine. The machine has 90 arms on 2½-ft. centres travelling 5 ft. per min. Each arm has a capacity of 80 lb. of ware. The tanks are 5 ft. wide and 6 ft. deep. Steam is used for heating, and the dryer is heated with gas burning in a loose muffle.

The solutions which are used in the pickling cycle are indicated as follow:—

Developments in Vitreous Enamelling in U.S.A.

(1) *Emulsion-type cleaner.*—The strength of this solution is maintained at 2.9 to 3.4 per cent. sodium oxide at a temperature of 210 deg. F. and an immersion time of 3 min.

(2) *Hot rinse.*—The rinse water is held at 100 to 120 deg. F. and the immersion time is 3 min.

(3) *Saponification-type cleaner.*—The concentration of this solution is equivalent to 2.0 to 2.5 per cent. sodium oxide at a temperature of 210 deg. F., and the immersion time is 3 min.

(4) *Hot rinse.*—Same as (2).

(5) *Cold rinse.*—Room temperature.

(6) *Sulphuric-acid solution.*—The concentration of this solution is maintained at 4 to 5 per cent. sulphuric acid at a temperature of 150 deg. F., and the immersion time is 4 min.

(7) *Cold rinse.*—Sulphuric acid is added to obtain a *p*H value of 3.0 to 3.5. The immersion time is half a minute.

(8) *Nickel-deposition solution.*—This solution is held at a concentration of 1.3 to 1.5 per cent. per gallon of nickel sulphate. This solution is maintained at a *p*H 3.2 to 3.5 by the addition of sulphuric acid or flake caustic. The operating temperature is 170 deg. F., and the immersion time is 5 min.

(9) *Acid rinse.*—This solution is acidified with sulphuric acid to obtain a concentration of 0.15 to 0.20 per cent. sulphuric acid. The temperature is 90 deg. F., and the immersion time is half a minute.

(10) *Neutralizer.*—This solution is held at a concentration equivalent to 0.2 to 0.4 oz. per gall. of sodium hydroxide and 0.28 to 0.56 oz. per gall. of sodium cyanide. The temperature is 130 to 140 deg. F., and immersion time is 3 min.

(11) *Neutralizer.*—This is a borax solution equivalent in concentration to 0.05 to 0.08 per cent. sodium oxide. The temperature is 130 to 140 deg. F. and the immersion is 1½ min.

Other Factors

Good millroom practice and procedure for the application of titanium enamel direct to titanium steel require the use of separate mills for grinding the titania-opacified frit. The water used in the grinding is filtered. Upon completion of grinding, the enamel is adjusted to a specific gravity of 1.76 before unloading. The net specific gravity of the unloaded enamel in the storage tank is between 1.74 and 1.75.

Before transferring the enamel to a storage tank, it is checked for fineness, specific gravity, colour, and acid resistance. The colour and acid resistance are checked by spraying sample plates and firing them in the production furnace (1,500 to 1,520 deg. F., 4½ min.). In filling the spray barrels, the enamel is roto-sprayed and passed through a magnetic separator.

A typical milling formula is as follows:—

100 Ohco A. R. Tite-Wite frit 970.
1½ Ohco clay 528.
½ 1A-4266 tinting oxide.
¼ Bentonite.
¼ Sodium aluminate.
¼ Potassium carbonate.
1/16 Sodium nitrite.
1/16 Gum tragacanth.
¼ Urea (after milling).
Grind 0-1 on a 200-mesh screen.

COLOURS IN TITANIA-OPACIFIED FRITS

All enamellers are very much interested in the problem of obtaining stable colours in titania-opacified frits. The following remarks from the *Proceedings* of the Porcelain Enamel Institute Forum of 1952 concern this subject.

Stable coloured titania-opacified enamels are not really new. In 1947 and 1948 when titania enamels were reaching a high level of acceptance because of their excellent properties, it was necessary to match the pink tint of the zirconia-opacified enamels. This was accomplished by the addition of small amounts of gold-tin pink oxides, and the resulting colour was stable. Other colours obtained by the use of standard oxides, unfortunately, at that time were not sufficiently stable. Shortly, however, it was found that a chrome-free yellow produced a creamy tint for which there was some demand. The pink- and cream-tinted white enamels were not thought of as pastel colours.

Further study of the problem has so progressed that at present a complete range of stable pastel colours is available which successfully meets the varying firing conditions, with respect to both temperature and time, encountered in the industry. Several large organizations are already in the process of establishing colour standards and procedures for the regular production of stable pastel-coloured titania-opacified enamels.

Since the publication of the above information, tremendous quantities of sanitaryware, refrigerator liners, and washing-machine tubs have been produced successfully with titania-opacified enamels.

LUMINESCENT ENAMELS

Luminescent enamels form a subject which is of great current interest.

In introducing this novel and new type of porcelain enamel, it might be well to first explain its unique properties. Luminescent porcelain enamels are those which emit light of various colours when excited by ultra violet or "black light." If these enamels give off light during excitation, they are said to be fluorescent; if they continue to emit light after excitation is discontinued, they are said to be phosphorescent. Many of the enamels developed display both of these properties. Conventional porcelain enamels do not fluoresce, but appear black or velvety purple blue under "black-light" excitation.

Black light can be obtained from 15-w. 360 BL fluorescent tubes, whose walls are made of ultra-violet-transmitting cobalt-blue filter glass. These

tubes may be mounted in an ordinary drafting fixture. All 360 BL fluorescent tubes from 4 to 40 w. may be mounted in standard fluorescent fixtures. The usual installation, however, uses clear glass-walled 360 BL tubes and a properly filtered exclosure fixture containing a reflector. Numerous manufacturers make such fixtures for either indoor or outdoor exposure. For display work, the black light is allowed to remain on at all times and the most startling, dramatic effects gained by intermittently flashing white incandescent lights on and off.

Applications

The weather resistance of luminescent porcelain enamel is deemed far superior to that of other luminescent coatings and may be reckoned in years rather than in weeks or months. Weatherometer tests have disclosed that a number of developed luminescent enamels are capable of withstanding at least the equivalent of three years of outdoor exposure when processed with a light acid-resisting glaze coat. The weather resistance of unglazed samples follows closely the pattern of weather resistance established by the Porcelain Enamel Institute and the National Bureau of Standards and is somewhat variable. A complete set of 96 glazed and unglazed samples is at present undergoing tests by the laboratory of a large electrical manufacturing concern.

The black-light colour palette available at present consists of several shades of blue, plain and mottled, light and dark green, chartreuse, and orange, orange-red and orange-yellow. At least six different colours appear practical, but no true strong reds or yellows have been achieved. The daylight colours range from white to dark cream and light tan.

The "selling" features of luminescent porcelain enamel over other luminescent mediums include its high abrasion resistance, its relative chemical durability, its superior weather resistance and ease of cleaning. Possible uses might well include such applications as:—

(1) Advertising spectaculars; (2) store signs and fronts; (3) interior murals for restaurants and bars; (4) theatre letters and marquees; (5) aisle, exit, entrance and warning signs; (6) gas station trim; (7) directional markers; (8) naval and military uses for blackout conditions; and (9) displays of porcelain-enamelled products.

SPRAYING AND GRINDING

Of particular interest to the production men in the industry would be some of the latest developments with regard to application of enamel and grinding of frit. Three relatively new developments in the spraying process have been promoted in recent years:—(1) Automatic spraying; (2) low-pressure spraying; and (3) electrostatic spraying.

Automatic Spraying

Any item that can be hand-sprayed can be automatically sprayed, providing the engineering time and investment is made. Problems of this nature must be weighed carefully in order to determine the feasibility of the project. The feasibility of the project can be determined by answering such questions as:—Will my production amortize the capital investment?; will the improvements in finish with the corresponding decrease in rejects justify the equipment? and is the machine a special that must be replaced if I change models?

There are two basic types of machines: the reciprocating type and the spindle type. Each has its place: the reciprocating machine is used for spraying flat work either laying on a lay-down conveyor, or hanging from an overhead conveyor; the spindle machine is used for spraying objects that must be rotating while they are being coated. There are many variations of the two basic types that may be used to adapt the machine to the object being coated. A great deal of time and work is being devoted to the automatic spraying of such items as washing-machine tubs, sinks, bath-tubs, refrigerator food liners, hot-water tanks and many other items.

Low-pressure Spraying

This subject has been covered well. It does have advantages and limitations. A definite amount of material can be broken up with a definite amount of air. Therefore, by cutting pressures, the pressure volume constant has been cut, which means the amount of material being broken up per unit time has also been cut. To maintain production, a greater percentage of material being delivered is applied to the ware than was possible with high pressures, resulting in better finish with less overspray. The answer to this is the development of better spray technique. Therefore the speed of a gun is dependent upon the capacity of the air nozzle at the pressure used. Here again the nozzle engineer is governed by basic laws and the most satisfactory nozzle falls in a capacity range of 14¼ to 15½ cub. ft. per min. at 50 lb. Since the air nozzle definitely controls the breakup and speed of a gun, this is usually the only change necessary to go to low-pressure spraying. Generally speaking, it requires 1 cub. ft. per min. to break up one ounce of material. No operator can efficiently spray or control more than 20 ounces per min

Electrostatic Spraying

The pioneers of this process state that it is only adaptable to 30 per cent. of the problems in the paint field. A great deal of work has been done on electrostatic spraying. However, to date, there has been very little success. In the enamelling field, it has been found to be partially successful in coating very small items. It develops that more work must be done before the possible success of the process can be ascertained.

The spray equipment manufacturer is constantly working on the development of special equipment adaptable to special problems. Even though they carry as standard catalogue items many types of extensions, guns, nozzles and tanks, there are cases where specials must be made. As a result, the

equipment manufacturer is constantly working on special problems and is always ready to help with application problems.

High-density Grinding Media

Until a year or so ago, pebbles or porcelain balls were used in the milling of enamels. Recently balls of zirconia or dense alumina (Burundum) have been introduced. It has been shown that the milling time is reduced 45 per cent. where no increase in charge was made, and an average reduction of 38 per cent. where the mill charge was increased 46 per cent. The cost of the milling operation was reduced approximately 20 per cent. The disadvantages are more wear on gears and mill linings, increase in slip temperature, and increased set of enamel; but where added milling capacity is needed, the disadvantages are of small importance.

ADHERENCE METER

Laboratory technicians and those responsible for inspection of enamels will no doubt be very much interested in the new adherence meter. For many years American enamellers have used the dropping-bar test to determine the adherence of enamels to the steel base. The results are entirely qualitative and depend upon the opinion of the individual observer. A quantitative method which can be operated under controlled conditions, and the results of which can be expressed in numbers which have a definite meaning, regardless of where the tests may have been made, has been developed by the Quality Development Committee of the American Porcelain Institute.

This method depends upon the use of a hydraulic deforming press, equipped with a set of dies, each number of which is specified for a given thickness of metal. The enamelled plate is supported on the deforming die mounted on the ram of a hydraulic jack. Motion of the jack forces the specimen against a stationary steel ball centred above the die. The deforming time and pressure are specified so that all specimens receive the same treatment.

The extent to which the enamel has been removed by the deforming process is measured with an electronic instrument equipped with 169 needle-like probes assembled in a hexagonal pattern 1.21 in. across the flats and 1.40 in. across the corners. Each probe is connected to an electric circuit, which may be completed through the grounded base metal of the specimen. On operation, the cluster of probes is lowered on to the deformed area, and each probe that touches bare metal completes a circuit, thus activating a counter which indicates the total number of probes that touch the metal base. This number is a measure of adherence; the higher the number, the poorer is the adherence.

CONCLUSION

In conclusion, it might be said that there is nothing mentioned in this Paper which could not be introduced into any organization. Perhaps some of them are already being used, since they have all been published in the technical literature. However, an attempt has been made to condense into a short account what the Author considers to be the most outstanding developments in the last few years.

Board Changes

ROBERT FLEMING & COMPANY, LIMITED—Mr. Gerald J. Jamieson has been appointed managing director.

W. G. BAGNALL, LIMITED—Mr. H. Davies, formerly general manager, has been appointed a director of the company.

HENRY GARDNER & COMPANY, LIMITED—Mr. E. A. Barrington and Mr. J. A. MacKinnon have been appointed to the board.

KENT ALLOYS, LIMITED—Mr. H. E. Hill has been appointed chairman, and Lt.-Col. J. C. Day and Mr. J. B. Frew have resigned their directorships.

NATIONAL SMELTING COMPANY, LIMITED—Mr. C. H. Elms and Mr. E. F. Stoker have been elected directors. Mr. A. E. Higgs has relinquished his directorship.

THE ROVER COMPANY, LIMITED, announces that Mr. Allan Botwood, who recently resigned his position as managing director of Harry Ferguson, Limited, will be joining the company early in the New Year to take charge of sales.

HILLS (WEST BROMWICH), LIMITED—Mr. R. S. Perkins has retired as a director, but will be appointed a special director, and remain managing director of the subsidiary, Wottons (Croydon), Limited. Mr. John MacNish has been elected director and appointed chairman of the parent company.

Changes of Name

Among the companies which have lately assumed new titles are the following, the new names being given in parentheses:—

FLINT ENGINEERING COMPANY, LIMITED, London, S.W.1 (Cofad, Limited).

ADVANCE MACHINERY COMPANY, LIMITED, London, E.C.4 (Advance Machinery, Limited).

EXCELSIOR GAUGE COMPANY, LIMITED, Birmingham (Second Era (Birmingham), Limited).

AVERY & CLARKE (ENGINEERS), LIMITED, London, N.W.10 (A. & C. Toolmakers, Limited).

GILLOTT ELECTRO STEAM COOKERS, LIMITED, London, S.W.1 (Gillott Electro Appliances, Limited).

J. L. TOMEY, LIMITED, mechanical and electrical engineers, etc., of Birmingham (Fourth Era (Birmingham), Limited).

ROTARIES (COMPONENTS), LIMITED, manufacturers of compressors and pumps, etc., of London, E.C.2 (Nichols (Patents), Limited).

WILLIAM RIGLEY & SONS, LIMITED, engineers and wagon manufacturers, etc., of Nottingham (William Rigley & Sons (Holdings), Limited).

Contracts Open

BATH, January 23—Supply of cast-iron manhole covers and frames, and road gully gratings and frames, for the year commencing April 1, 1954, for the City Council. The City and Waterworks Engineer, Guildhall, Bath (Somerset).

HERTFORD, January 25—Supply of iron castings for the Borough Council. The Borough Engineer and Surveyor, The Castle, Hertford.

LONDON, S.W.1, January 18—Supply of iron castings for the 12 months commencing April 1, 1954, for the Battersea Borough Council. The Borough Engineer and Surveyor, Town Hall, Battersea, London, S.W.1.

LONDON, W.8, January 19—Heavy iron and mild steel for the 12 months commencing April 1, 1954, for the Kensington Borough Council. The Town Clerk's Office, Town Hall, Kensington, London, W.8.

TWICKENHAM (MIDDX), January 30—Supplies of iron castings, street gullies, and drain pipes, for the 12 months from April 1, 1954, for the Town Council. Alfred S. Knolles, borough engineer and surveyor, Municipal Offices, Twickenham.

Book Reviews

Manufacture of Iron and Steel, by D. J. O. Brandt, B.Sc., A.R.S.M., published by the English Universities Press, Saint Paul's House, Warwick Square, London, E.C.4. Price 15s.

So highly esteemed as criteria of knowledge of the industry are the City and Guilds' examinations in iron and steel manufacture, that this modestly-priced book—issued jointly under the auspices of the C. and G., and the British Iron and Steel Federation—will have instant appeal to all student operatives who aspire to academic success. Indeed, it is written for their benefit principally; yet throughout the 45 chapters and five appendices much is revealed of the basic principles of their sister industry to serve as background knowledge for foundrymen.

Though there is a whole section of three chapters devoted ostensibly to ironfounding, one of these relates to wrought-iron production, and the treatment of founding, as one would perhaps expect, is rather superficial. This mild criticism also applies to steelfounding. Here, although some of the melting and processing is undoubtedly shared in the sections of the book dealing with ingot production, there is only one page devoted to pouring metal into sand moulds; heat-treatment, for example, is not mentioned in this context.

The book is very clearly printed, well illustrated, and built up on a commendably logical sequence, an innovation being a foreword to each section and recapitulatory chapters to link up the whole. Sections in addition to that cited deal respectively with ironmaking (meaning pig-iron production); steelmaking, finishing processes, and integration, layout and location. That on finishing processes is the best written and most informative; it occupies 158 out of a total of 375 pages. Appendices cover refractories, pyrometry, testing, alloys and heat-treatment and examination questions plus an index.

A chatty style of writing, using the personal " we," *e.g.* (p. 182), " As we travel from left to right across Fig. 90, ... " creeps in occasionally, and this the reviewer dislikes, but otherwise the whole work is carried out with praiseworthy clarity, and is easy to read and follow. Undoubtedly, it is about time some of the outdated classics on iron and steel manufacture were given an honourable burial, and this new compendium of information should hasten this process.

A. R. P.

Guide Practique du Tracé des Pièces en Acier Moulé (2nd Edition). Practical Guide to the Designing of Steel Castings. Published by Editions Techniques des Industries de la Fonderie, 12, Avenue Raphaël, Paris 16. Price 480 French francs, plus postage.

This guide has been brought to fruition by the Technical Committee of Steel Metallurgy of the *Centre Technique,* which since 1945 has been devoting itself in close accord with the French Association of Steel Founders. As a result of this, the first edition appeared in 1948, and has had a wide circulation amongst steelfounders and their clients. The edition having become out of print, the technical committee decided during 1952 to issue an unaltered second edition.

The object of this brochure, which runs to 64 pages and is well and clearly illustrated, is to provide designers with the essential rules in order that sound castings can be produced at an economical price. To do this the general properties of steel castings have been set forth and the chief defects due to poor design are discussed.

The two most important chapters are devoted to the rules of designing by discussing the conception of the general shape of castings, from the dual point of view of foundry technique and engineering properties; the second one deals with design modifications as related to casting and to moulding to give soundness associated with economy. The reviewer strongly recommends this book to the attention of both founders and designers, as both can materially profit from studying it and much benefit would result from the publication of an English edition.

Fehlererscheinungen an Gusstücken (Occurrence of Defects in Castings), by Dr. Erwin Knipp. Published by Giesserei-Verlag G.M.B.H., 27 Breite Strasse, Düsseldorf, price D.M.26.

This is an ambitious book covering a wide range of materials and defects. Whilst one expects an author to have had a considerable experience of his subject it would be wrong to expect the author to have knowledge of all of the defects which he has described.

The book is for foundrymen. To begin with, the author deals with essential principles for the production of sound castings and the elimination of defects. This section is concerned with the feeding of castings and the design of runners, risers and ingates. Gas evolution, slag and sand inclusions are also dealt with. There is an interesting section on scabbing and also on hot and cold cracking. After the general treatment, the individual casting alloys are dealt with. Cast iron, malleable cast iron and steel castings are dealt with at considerable length. In connection with cast iron, defects arising during enamelling and defects in chilled rolls are dealt with. These instances are quoted here to illustrate the range of the book.

No fewer than 280 references are given in the bibliography, so the book can be regarded as a useful source of detailed information. Since the author has had to cover such a wide field, he naturally has had to take a very simple view of some defects and their cure. It would probably have been better if he had edited specialized contributions on each type of casting, prepared by others with detailed experience of each. The book has a good index and the author has not refrained from giving scientific explanations where they apply.

Control of Quality in the Production of Wrought Non-ferrous Metals and Alloys. I—Control of Quality in Melting and Casting—A symposium, published by the Institute of Metals, 4, Grosvenor Gardens, London, S.W.1. Price 15s.

This book, it should be noted, is devoted to the melting and casting of non-ferrous metals and alloys for the production of ingots and not castings. It is obvious, however, that if a foundry manager can pour into his moulds an alloy of which the composition and temperature are strictly controlled, then a variable of a critical nature has been eliminated. It is here where this book can be useful.

It contains half a dozen papers—the first, dealing with the underlying principles, is by Dr. Singer. There follow papers on brass ingots (Dr. Maurice Cook); copper (Mr. J. Sykes); zinc (Mr. C. W. Roberts and Mr. B. Walters); aluminium (Mr. R. T. Staples and Mr. H. J. Hurst); and magnesium (Mr. R. G. Wilkinson and Mr. S. B. Hirst). It is a real pleasure to comment on the excellence of the illustrations, because with some of the microstructures of the alloys covered it is no easy task to prepare photographs and reproduce them so as to retain the perfection of the original. The discussion could have been improved by changing to third person. The book can be studied with profit by all whose job it is to control the melting of non-ferrous alloys.

News in Brief

MR. WILLIAM WHITELEY, of Bournemouth, formerly of Leeds, retired ironfounder, has left £36,994 (net £36,904).

THE 27TH CONGRESS of the *Association Technique de Fonderie Française* will be held during the last week of May, at Lyons.

EMPLOYEES at the Kynoch works of I.C.I., Limited, raised nearly £800 at Christmas for various charitable causes in Birmingham.

PRELIMINARY WORK on the £1,750,000 improvement scheme at Shoreham Harbour is to begin shortly. The main work will commence in the Spring.

BRITISH ELECTRO METALLURGICAL COMPANY, LIMITED, announce that their new address is now 103, Mount Street, London, W.1, telephone Grosvenor 8201.

KENT ALLOYS, LIMITED announce that Mr. H. E. Hill has been appointed chairman. Lt.-Colonel J. C. Day and Mr. J. B. Frew have resigned their directorships.

AMONG the fifteen new magistrates appointed for Derby, is Mr. W. J. Brown, managing director of Brown's Foundry Company, Limited, Nottingham Road, Derby.

THE TARGET FIGURE of £100,000 for the guarantee fund of this year's Scottish Industries Exhibition has already been reached, only eight weeks after the appeal was launched.

IN THE TICKENHILL COLLECTION of Midland bygones is preserved an ancient specimen of a "hot-water" bottle which consists of a muff heater, made of metal into which hot charcoal was inserted.

MIDLAND IRON & HARDWARE COMPANY, (CRADLEY HEATH), LIMITED, announce that an extra-ordinary meeting is called for January 14 to effect the one-for-one scrip issue to holders at December 18.

NEWMAN INDUSTRIES, LIMITED announce the appointment of Mr. Charles Bush and Mr. George Redfern, to the Board of directors. Mr. Bush will retain his position as secretary and Mr. Redfern as chief engineer.

CONSTRUCTION is to start early this year at Vancouver of new steel plant for the production of pipe and tubing. Planned by Canadian Western Pipe Mills, it is the first of its kind in West Canada; the cost is about $3,000,000.

MR. WILLIAM HEPWORTH, chairman and managing director of Hepworth and Grandage, Limited, Bradford, on Christmas Eve presented gold watches to 12 employees in recognition of 25 years' continuous service.

OUTPUT OF ENGINEERING PRODUCTS from the Distington Engineering Company, Limited (Cumberland), increased during 1953 by 45 per cent. compared with 1952, while output at the firm's foundry rose by 13 per cent.

ALDRIDGE (WALSALL) URBAN DISTRICT COUNCIL'S PLANNING COMMITTEE reports that sites on the Leighswood Industrial Estate have been sold to two firms: Hall Foundries, Limited, and the Asbestos Washer Company, Limited.

THE CALCULATION of roll force and torque in hot-rolling mills is described in a paper presented recently by R. B. Sims, research manager of Davy & United Engineering Company, Limited, to the Institution of Mechanical Engineers.

FOLLOWING THE VISIT of a Russian trade delegation to textile-machinery manufacturers in Lancashire and Yorkshire, a group of British textile-machinery experts will visit Moscow early this year to examine Russian requirements in detail.

AT THE ANNUAL DINNER in Wolverhampton recently of the John Thompson Supervisors' Association, Mr. E. W. Thompson, chairman and managing director, presented medals for long service. Mr. F. Mills, vice-chairman of the association, of the Dudley works, presided.

J. BROCKHOUSE & COMPANY, LIMITED, iron and steel manufacturers and engineers, of West Bromwich, Staffs, have concluded negotiations with the Iron and Steel Holding and Realization Agency for the re-purchase of the company's former subsidiary, the District Iron & Steel Company, Limited.

NUMBER 19 "FactVeyor"—one of a series of card blotters printed with useful data for engineers and foundrymen, issued by J. Collis & Sons, Limited, Regent Square, Grays Inn Road, London, W.C.2—contains useful reciprocals mainly for the conversion both ways of British and metric units.

TO MEET a strong demand in industry that the implications of changing attitude to the problem of human relations in industry should be thought out, a conference on "The Young Worker: Education for Human Relations" has been arranged for April 3-9, 1954, by the Department of Education, Oxford University.

THE GERMISTON (Glasgow) factory of Metropolitan-Vickers Electrical Company, Limited, has received an important share of the £500,000 order received recently from Canada. The Glasgow factory will supply the auxiliaries for the steam turbo generation for the contract from the Calgary (Canada) Power Company.

THE PRICE OF GAS will go up in all districts of Scotland by about ¾d. a therm from April 1 next. Last year the Scottish Gas Board was the only one which failed to make a profit. There was a working loss of £270,000, to which had to be added a deficit carried over of £94,000. Under the new tariff the Board hopes to increase its income by about £650,000.

TWENTY-FIVE LARGE COMPANIES have joined the five-year scheme of commercial apprenticeship first introduced in 1945 by the Darlaston engineering firm of Rubery, Owen & Company, Limited, and which had gained "considerable national fame," Mr. Harold Harman, principal of the County Commercial College, Wednesbury, told the company's apprentices at their annual prize-giving.

A CONTRACT worth £635,000 has been secured by Ruston & Hornsby, Limited, Lincoln, for the supply of eight gas turbines for the London County Council's northern outfall purification plant at Beckton. All the turbines will use sewage gas as fuel, and as far as fuel is concerned the station will be self-supporting. It is expected that the station will come into operation during 1957.

NEGOTIATIONS have been concluded for the acquisition of the capital of Earle, Bourne & Company, Limited, manufacturers of rolled metal, brass and copper tubes, etc., of Birmingham, by Delta Metal Company, Limited, London, S.E.10. Mr. L. Endall and Mr. A. J. Bourne have agreed to remain on the Board of Earle Bourne & Company and the business will be conducted on the same general lines as hitherto.

BONUS AWARDS amounting to £1,680, an increase of almost £400 compared with last year, have been earned by apprentices employed by Babcock & Wilcox, Limited, Renfrew. Seven apprentices gained awards for five years' perfect attention to duty, and 29 were given

(*Continued on page* 28)

For your special attention

THE ASSOCIATION OF BRONZE & BRASS FOUNDERS

ANNOUNCE

AN ADVISORY SERVICE

For ALL Bronze & Brass Founders

TO IMPROVE EFFICIENCY

Factory Layout, Mechanical Aids, Costing, Melting Practice, Technical Problems

The INAUGURAL Meeting in your area will be

London Area. 14th January. Great Western Royal Hotel, Paddington Station, London, at 2.15 p.m.

Midlands Area. 26th January. Victoria Hotel, Wolverhampton, at 2.15 p.m.

Scotland. 2nd February. St. Enochs Hotel, Glasgow, at 2.15 p.m.

North West Area. 18th March. The Engineers' Club, 17 Albert Square, Manchester, at 2.15 p.m.

Yorkshire Area. To be announced later.

Secretaries: HEATHCOTE & COLEMAN, 69, HARBORNE RD., BIRMINGHAM, 15
Telephone: EDG 4141

News in Brief

(*Continued from page* 26)

National certificates, and 19 London City & Guilds certificates. The managing director's prize for the year was won by D. S. Gibson, a fifth-year apprentice.

SEDDON MOTORS, LIMITED, of Oldham, placed a provisional order for 250 gear-boxes required for a new 25-cwt. Diesel-engined van with a 2.6 litre engine. They wanted the first six prototype gear-boxes urgently to enable the van to be introduced at the Scottish Motor Show in November. David Brown and Sons (Huddersfield), Limited, saw to it that they were supplied in time, and in consequence the order has been increased to 1,000.

THE COURT OF APPEAL, London, decided recently that a statement that an employee has been dismissed is capable of defamatory meaning. The point was raised in a libel action brought by two sales managers against their former employers. The plaintiffs complained of a circular letter to customers in which the firm said that they had been dismissed. They claimed that they had resigned, and that it was defamatory to say that they were dismissed.

TWO PAXMAN-ENGINED six-wheel heavy Diesel-electric shunting locomotives have just been delivered by the Yorkshire Engine Company, Limited, one to the Hawarden works of John Summers, Limited, and one to the Sheffield plant of Samuel Fox and Company, Limited. Powered by 12-cylinder engines of 400 h.p. and with B.T-H. electrical equipment, they are the most powerful steelworks Diesels yet in service in Great Britain.

TURNER MANUFACTURING COMPANY, LIMITED, Wolverhampton, have acquired about eight acres of land in Wolverhampton and plan to build a new factory there which may, eventually, have a floor area of approximately seven-and-a-half acres. The company has recently announced a new range of two-stroke Diesel engines, and the development of the new factory may wait upon the results of the successful launching of these products.

IN ORDER to facilitate the more rapid compilation of trade statistics, the Canadian Department of National Revenue has agreed to furnish the Dominion Bureau of Statistics with a copy of each customs import entry for use and retention by the Bureau. Commencing April 1, 1954, import entries will be required to be presented at Customs in triplicate at ports and quadruplicate at "out" ports, instead of in duplicate and triplicate as at present.

NO FEWER than 300 delegates attended a two-day autumn conference held by the technical section for the Swedish Foundrymen's Association at Göteberg. Representatives from Norway, Denmark and Finland attended. Mr. Abdolfsson of Svedala was elected chairman and Mr. S. Arnell vice-chairman. Papers were presented on hot-blast cupolas (Mr. Bertel Thyberg) and shell moulding (Mr. K. E. Johansson) whilst a film on charging and operating a cupola was shown.

THE HORSEHAY COMPANY, LIMITED, of Dawley, Shropshire, which is associated with the Adamson Alliance Company, Limited, the well-known crane builders, will share in an order just secured from a large steelworks in India, for melting-shop cranes, valued at nearly half a million pounds. The contract, which includes two very large cranes, each of 250 tons lifting capacity, was obtained against severe competition from the United States, Germany, and from other British firms.

OVER TWELVE TONS of British coinage bronze has been used by The Mint (Birmingham), Limited, to make 450,000 souvenir medals for New Zealand schoolchildren to commemorate the Royal visit. The obverse side shows the Queen's head from the official die supplied by the Royal Mint to the design of Mr. G. H. Paulin. The reverse side shows the New Zealand coat of arms with "Elizabeth II" and "Royal Visit 1953-4" surrounding it. The order was completed in six weeks.

MR. HARRY L. DOWSETT, chairman of the operating companies forming the Dowsett Engineering Group, and Mr. D. B. Cunningham, director and general manager of Brooke Marine, Limited, Lowestoft, left for Moscow on Tuesday to continue negotiations in respect of trawlers and other vessels required by the U.S.S.R. Mr. Dowsett stated that neither the type nor the number of vessels had been settled, and it could not be taken for granted that any contract would automatically result from the visit.

EMPLOYEES of E. W. Wynn, Limited, a Bridgtown iron foundry firm, which is now an associate of the Cincinnati Milling Machine Company, Limited, of U.S.A., are benefiting by the introduction to Cannock of a Christmas custom traditional to industry in America, the original home of the turkey. Each of the 280 workpeople at Wynn's has received from the firm a 12-lb. turkey, and the 970 employees at a Birmingham associate factory of the American firm have each received a similar gift.

BARROW IRONWORKS, LIMITED, Barrow-in-Furness, Lancs, announce that preparations are being made to put another furnace into blast which, it is expected, will be in operation by the end of 1954. Hitherto, it has been the practice for two furnaces to be in blast at once, but a new furnace, bigger than the others, has been built and is awaiting delivery of ancillary plant before going into operation. With the new furnace, it is expected that the works will increase production by about 60 per cent., and employ about another 100 men.

PROGRESS is being made with building work on the new £1¼ million foundry, with baths and dust-free floors, being build by W. & T. Avery, Limited, owners of the oldest foundry in the Midlands. The new foundry—at Tame Bridge—will have clothes lockers as well as baths for the workmen. The Soho Foundry will gradually stop work as the new plant comes into production in 1954. At a presentation on December 18 at the old works, 15 apprentices received awards worth £110. One of them, Mr. H. Middleton, won an award for foundry practice.

MR. H. O. MISSENDEN, of Birmingham, who is general manager of the Birmingham section of the British Industries Fair, is advising the organizers of the first British Trade Exhibition to be held in Portugal next June. With the consent of the Birmingham Chamber of Commerce, he recently spent a week in Lisbon. The exhibition, which is arousing lively interest, is being organized by the British Chamber of Commerce in Portugal to give British manufacturers an opportunity for demonstrating the quality and strength of British industry, and thus maintain Britain's leading position in this market.

THE NEWLY-FORMED Beds. & Herts. section of the London branch of the Institute of British Foundrymen has now formulated its programme for the rest of the current session and details are available from the hon. secretary, Mr. W. Twaddle, 108, Great Northern Road, Dunstable. The next meeting is to be held in the premises of W. H. Allen Sons & Company Limited, Bedford, on January 14 when a film "Modern Malleable" will be introduced by Mr. A. F. Stevens. The first social event of the section is to be a "Men Only" dinner at the Bridge Hotel, Bedford, at 7.15 p.m. on February 5, tickets to be obtained from the secretary.

F.&M. FERRO-SILICON BRIQUETTES

F. & M. SILICON BRIQUETTE

It is well known that the hardness of ordinary cast iron depends to a large degree on the Silicon content of the metal. Silicon acts as a softening agent in cast iron by its action in reducing the amount of combined carbon, which is liberated in the form of free graphite. The presence of free graphite and a low combined carbon content contribute towards easy machineability.

For the past twelve years, F. & M. Supplies Ltd. have provided in their Ferro-Silicon Briquettes a practical, convenient and economical means of increasing the amount of Silicon in a cast iron. The necessary number of Briquettes is added to the charge in the Cupola and all the Silicon contained in the Briquettes passes into the molten metal with only a negligible loss *because the element is protected during its progress through the oxidising zone.*

An important function of **F. & M. Ferro-Silicon Briquettes** is in the production of dense iron castings with high tensile strength. The foundryman usually ensures sufficient "softness" in his castings by using a pig iron with 3 to 4 per cent. Silicon. Such pig irons are frequently coarse-grained with large graphite flakes and, when used in ordinary cupola mixtures of pig and scrap iron, are apt to give rise to castings containing large graphitic flakes. This coarse-grained structure, which is particularly developed in the thicker parts of the section, results in an iron of comparatively low tensile strength.

By using pig irons of medium Silicon content (2 to 2·5 per cent. Silicon) which possess a denser structure owing to their smaller graphite flakes, and increasing the Silicon content of the metal by an appropriate addition of **F. & M. Ferro-Silicon Briquettes** to the cupola mixture, an iron with much smaller graphite flakes and, therefore, with a denser structure, is produced. At the same time, the metal is readily machineable, although it is denser and stronger, ***as the composition of the metal remains unaltered from that obtained by the use of higher Silicon coarse-grained pig irons.***

Technical advice for any special working conditions gladly given on request

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Personal

MR. C. J. HEWS, formerly a general manager, has been appointed to the Board of Morgan Crucible Company.

MR. J. W. BAILLIE, managing director of the Horseley Group of engineering works, is retiring, although he will continue to be a director. He has been in the active management of the company for 35 years.

MR. S. BEARDS has retired after 51 years' service with Ley's Malleable Castings Company, Limited, Derby. To mark the occasion he was presented with a wallet of notes by Major F. D. Ley, the managing director.

MR. J. C. WOOD has retired from active business after serving John Fowler & Company (Leeds) for almost 52 years. Mr. Wood will remain a director and will attend Board meetings in an advisory capacity.

SIR HENRY COOPER retired from his directorship of Wm. Cory & Son, Limited, on December 31. To fill the vacancy the Board have appointed Mr. T. C. Mellonie, manager of the fuel-oil department, to be a director.

MR. J. T. BURFORD, general works manager of W. & T. Avery, Limited, retires next April after 50 years' service with the company. Mr. Burford presented the awards to apprentices of the firm, at the recent ceremony at the works.

MR. W. MARTER FURNISS, who has been associated with the Electric Construction Company, Limited, Wolverhampton, for more than half a century, is resigning his directorship of the company as from to-day at the age of 83.

MR. WILFRED JESSIE BROWN, of Littleover, has been appointed a Justice of the Peace for the Borough of Derby. Mr. Brown is a director of Brown's Foundry and has for a long time been associated with the Boy Scout movement.

MR. NATHANIEL ALLAN, a director and works manager of Fullerton, Hodgart & Barclay, Limited, engineers and ironfounders, Paisley, has completed 60 years' service with the firm and been presented with an inscribed gold watch.

MR. EDWARD HIGSON AND MR. RICHARD ASHMORE, both fitters, have retired from Bamfords, Limited, of Uttoxeter, with 68 years' service each to their credit. The chairman of the directors, Mr. H. B. Bamford, gave each a cheque in honour of the occasion.

MR. LESLIE ROSS HONEYWILL has relinquished his position as chief accountant of the Butterley Company, Limited, now that the compensation proceedings under the Coal Industry Nationalization Act have ended. Mr. Honeywill is to remain a member of the Board.

MR. A. HEALEY, an executive director of Dunlop Rubber Company, Limited, is retiring early this month after more than 38 years' service with the Dunlop group of companies. He has been chiefly associated with research, development and production. He has been a director since 1942.

MR. AND MRS. D. C. THOMAS, of Newtown, Montgomery, celebrated their golden wedding on December 23. Mrs. Thomas is a native of Kerry, and Mr. Thomas of Newtown. They have three daughters, three sons, and six grandchildren. Mr. Thomas, who worked at the Cambrian foundry for 56 years, is 79 and his wife is two years younger.

MR. A. W. BURTON, MR. E. CROSSE, MR. T. E. SILK and MR. R. ASKIN have now been appointed executive directors of J. Brockhouse & Company, Limited, ironfounders, etc. The intention to make these appointments was announced by MR. L. J. BROCKHOUSE, the chairman, at the annual meeting on December 30, 1953.

FOUR RETIRING FOREMEN from the Tubal Works at Barrhead of Shanks & Company, Limited, were honoured by the firm and colleagues when Mr. Wm. Stirling, personnel officer, presided over a company of 50 foremen, and Mr. R. R. Murray, works director, made the presentations. The foremen were Mr. W. Allison, Mr. W. Buchanan, Mr. A. McRae, and Mr. W. Turnbull.

ARMSTRONG WHITWORTH (METAL INDUSTRIES), LIMITED, announce that following the retirement of MR. JAMES H. BARRETT, local director and foundry manager, MR. JAMES L. SMITH, roll foundry manager, has been appointed to take full charge of the general and roll iron foundries at Close Works, Gateshead. Mr. Smith is also a member of the local Board of directors.

MR. A. B. LLOYD, sales director of F. H. Lloyd & Company, Limited, has undertaken a temporary appointment as a steelfoundry expert to advise the Government of India in connection with a survey of industrial capacity which is being carried out by that Government. The appointment has been made by the Commonwealth Relations Office, under the technical co-operation scheme of the Colombo Plan.

MR. RONALD BROWN, managing director of Scotts' Shipbuilding & Engineering Company, Limited, Greenock, was elected president at the annual general meeting of the Scottish Engineering Employers' Association in Glasgow last month. Mr. Brown is the third executive of the 250-year-old firm to hold this office. The new vice-president is Mr. J. W. Rodger, managing director of Bruce Peebles & Company, Limited, Edinburgh.

SIR HARRY BROWN, who is now 75, has resigned from the chairmanship of the British General Electric Company Pty., of Australia (a subsidiary of General Electric Company), a position he has held since 1940. MR. T. E. MORGAN, at present managing director of the Australian company, has been appointed chairman and managing director. At the same time MR. A. T. BRIDGE, MR. R. J. DARTON, and MR. C. DRABBLE have been appointed directors.

MR. I. M. LYON, who joined the staff of Babcock & Wilcox, Limited, Renfrew, 30 years ago, as a draughtsman, retires this week, having become in the interim general manager of Renfrew and Dumbarton works. In the early days he carried out special investigations in connection with the manufacture of castings. To mark his retirement, a presentation was held in the work's canteen on Christmas Day, when he was honoured by firm, colleagues and employees.

COMMERCIAL DIRECTOR for the past ten years of George Dyke & Son, Limited, Miss P. E. Thompson received a marcasite necklace from her fellow directors last week, to mark her retirement. The presentation was made by Mrs. Lindop, wife of Colonel C. A. B. Lindop, chairman of the company. Miss Thompson joined George Dyke & Son, which was earlier this year acquired by H. & J. Hill (Willenhall). Limited, just before her father, a director, died.

MR. H. EYLES, who retired recently after 25 years as secretary of the Birmingham Chamber of Commerce, and nearly 40 years in the service of the Chamber, received presentations from its council on December 21, at a luncheon in his honour. Lord Bennett of Edgbaston and Mr. S. F. Burman, former presidents of the Chamber, paid tributes to Mr. Eyles. From Mr. C. A. F. Hastilow, president of the Chamber, Mr. Eyles received a cheque, a set of pipes, and a refrigerator and gas cooker. Mrs. Eyles was presented with a wrist watch.

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Raw Material Markets

Iron and Steel

Most of the foundries are fairly well occupied. The engineering and speciality foundries continue to receive good support from the steelworks, collieries, machine-tool and power-plant equipment makers, and the agricultural implement manufacturers. During last year the removal of import restrictions in some countries abroad brought an increase in the demand for castings for the motor, tractor, and allied trades, and the foundries supplying these trades continue to obtain good outputs.

For practically the whole of the year the light-castings trade was very subdued. The recession in home business for household equipment, etc., coupled with the decline in orders from abroad, reduced the demand for castings to such meagre proportions that the light and many of the jobbing foundries were only partially employed and outputs were considerably reduced. The last month or so has witnessed a decided improvement in the call for light castings for home and export and the beginning of the new year finds them in a much more favourable position.

Pig-iron production last year provided a considerable increase on the 1952 figures, most of which was in basic steel-making iron for the steelworks. The furnaces have been provided with ample supplies of ore; imports were much in excess of the previous year's figures and home-produced ores have added to the total. Deliveries of blast-furnace coke have been on a better scale than was expected, and although there have at times been anxieties on account of both quantity and quality, deliveries have enabled producers of pig-iron to obtain record outputs from the furnaces in blast.

Production of the foundry grades of pig-iron has not been proportionate to the increase in outputs. Even with reduced outputs of castings the engineering and speciality foundries have had difficulty in obtaining their requirements of pig-iron. Outputs of the low- and medium-phosphorus irons have barely met consumption requirements and there is little prospect of any increase in the supply of these grades. During the year it was found necessary to import hematite to relieve the shortage of supplies from home sources. Production has increased, but there is little to spare and many foundries could take up larger tonnages than they are at present receiving.

The supply of the high-phosphorus grades of pig-iron for the light and jobbing foundries has been adequate, and present and future requirements based on current demands seem assured.

Deliveries of scrap to the foundries are generally on an adequate scale, and there has been little difficulty in securing the required tonnages of coke, ganister, limestone, and firebricks.

Non-ferrous Metals

The increase of £6 to £156 announced in the price of aluminium on January 1 did not by any means come as a complete surprise to the trade. Something of the kind, but perhaps not so much, had been expected during recent weeks. Consumption, which is only on a moderate scale, is not likely to be affected by this higher price, which leaves the value of the metal still £10 below the figure of 12 months ago. The prices of light alloy products such as strip and sheet are being advanced, and makers of brass and copper semis, who may have felt that aluminium was to some extent ousting their products, will not be sorry to note this increase in the price of the rival metal. The higher price or aluminium is believed to have been rendered necessary because of some deterioration of the £ against the Canadian dollar, coupled with higher wages costs at the centres of production. Whatever the reason, it may be doubted whether, if the copper price tumbles later on this year, the new level of £156 will be maintained. In due course there is going to be more than enough of both aluminium and copper to satisfy the world's requirements in these metals and when that time comes, or rather probably in advance of it, the copper quotation, at any rate, is likely to suffer a severe setback.

The Metal Exchange was closed last Friday—New Year's day—so that trading was limited to four days. On December 31 the price of cash copper was officially stated as £235 10s., with three months at £222, but in the afternoon there was a reduction of £1 in both positions, so that on the week cash closed £2 10s. up and forward also £2 10s. dearer. The turnover was only moderate. Lead was perhaps the most active metal, being subjected to some fairly heavy selling which brought about a net reduction of 10s. in December and of 5s. in March. The backwardation at the close was no more than 30s., and indeed on one occasion last week a contango was paid for January metal. Tin was fairly active and gained £7 for cash and £6 for three months. This metal certainly wears a firmer appearance, since there appeared to be some prospect of production being regulated, and we may well see the price go higher, but should the market's expectation of an agreement not be fulfilled, then values will undoubtedly relapse.

Official metal prices were as follow:—

COPPER, Standard—*Cash:* December 31, £235 to £235 10s.; January 4, £230 to £232; January 5, £230 10s. to £231; January 6, £232 to £232 10s.

Three Months: December 31, £221 10s. to £222; January 4, £219 to £220; January 5, £219 10s. to £219 15s.; January 6, £220 15s. to £221.

TIN, Standard—*Cash*: December 31, £655 to £657 10s.; January 4, £650 to £655; January 5, £661 to £662 10s.; January 6, £660 to £662 10s.

Three Months: December 31, £630 to £632 10s.; January 4, £630 to £632 10s.: January 5, £635 to £637 10s.; January 6, £636 to £637 10s.

ZINC—*January:* December 31, £74 15s. to £75; January 4, £74 7s. 6d. to £74 12s. 6d.; January 5, £75 to £75 5s.; January 6, £75 to £75 5s.

April: December 31, £73 10s. to £73 15s.; January 4, £73 5s. to £73 10s.; January 5, £73 15s. to £74; January 6, £73 15s. to £74.

LEAD—*January:* December 31, £89 5s. to £89 15s.; January 4, £89 5s. to £89 10s.; January 5, £89 10s. to £89 15s.; January 6, £89 10s. to £89 15s.

April: December 31, £88 to £88 5s.; January 4, £87 15s. to £88 5s.; January 5, £88 to £88 5s.; January 6, £88 to £88 5s.

I.V.E. New Members

The Council of the Institute of Vitreous Enamellers elected the following new members of the Institute at its last meetings:—

As Company Member.

Kymmene AB Hogförs Bruk, Hogförs, Karkkila, Finland (representative Mr. Göran Wickström).

As Members.

H. F. Beaumont, Wylde Green, Birmingham; J. Fyfe, Fenton, Staffs; D. J. Payne, Kingswinford, Staffs.

As Associate Members.

J. M. Barber, British Electric Resistance Company, Limited; W. D. Hannah, Handsworth, Birmingham; Werner Heimsoeth, Farbenfabriken Bayer Aktiengesellschaft; J. C. Richmond, Bethesda, 14, Md., U.S.A.

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Current Prices of Iron, Steel, and Non-ferrous Metals

(*Delivered unless otherwise stated*)

January 6, 1954

PIG-IRON

Foundry Iron.—No. 3 IRON, CLASS 2:—Middlesbrough, £13 18s. 0d.; Birmingham, £13 11s. 3d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £16 14s. 6d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si), d/d within 60 miles of Stafford, £17 0s. 3d.

Scotch Iron.—No. 3 foundry, £16 11s. 0d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £18 3s. 0d.; South Zone, £18 5s. 6d.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £19 3s. 0d.; South Zone, £19 5s. 6d.

Hematite.—Si up to 2¼ per cent., S. & P. over 0.03 to 0.05 per cent.:—N.-E. Coast and N.-W. Coast of England, £16 12s. 0d.; Scotland (Scotch iron), £16 18s. 6d.; Sheffield, £17 13s. 0d.; Birmingham, £17 19s. 6d.; Wales (Welsh iron), £16 18s. 6d.

Basic Pig-iron.—£14 6s. 6d. all districts.

FERRO-ALLOYS

(*Per ton unless otherwise stated, delivered*).

Ferro-silicon (6-ton lots).—40/55 per cent., £53 10s. 0d., basis 45 per cent. Si, scale 21s. 6d. per unit; 70/84 per cent., £82 10s. 0d., basis 75 per cent. Si, scale 23s. per unit.

Ferro-vanadium.—50/60 per cent., 23s. 8d. to 25s. 0d. per lb. of V.

Ferro-molybdenum.—65/75 per cent., carbon-free, 10s. 0d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, £165 0s. 0d. to £181 0s. 0d. per ton; 38/40 per cent., £229 0s. 0d. to £235 0s. 0d. per ton.

Ferro-tungsten.—80/85 per cent., 13s. 0d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 16s. 0d. per lb. of W.

Ferro-chrome (6-ton lots).—4/6 per cent. C, £85 4s. 0d., basis 60 per cent. Cr, scale 28s. 3d. per unit; 6/8 per cent. C, £80 17s. 0d., basis 60 per cent. Cr, scale 26s. 9d. per unit; max. 2 per cent. C, 2s. 0½d. per lb. Cr; max. 1 per cent. C, 2s. 1d. per lb. Cr; max. 0.15 per cent. C, 2s. 2d. per lb. Cr; max. 0.10 per cent. C, 2s. 2½d. per lb. Cr; max. 0.06 per cent. C, 2s. 2½d. per lb. Cr.

Cobalt.—98/99 per cent., 20s. 0d. per lb.

Metallic Chromium.—98/99 per cent., 6s. 3d. to 6s. 9d. per lb.

Metallic Manganese.—93/95 per cent., carbon-free, £225 0s. 0d. to £232 0s. 0d. per ton; 96/98 per cent., £255 0s. 0d. to £262 0s. 0d. per ton.

Ferro-columbium.—60/75 per cent., Nb + Ta, 52s. 6d. to 70s. 0d. per lb., Nb + Ta.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—BASIC: Soft, u.t., £25 12s. 6d.; tested, 0.08 to 0.25 per cent. C (100-ton lots), £26 2s. 6d.; hard (0.42 to 0.60 per cent. C), £28 0s. 0d.; silico-manganese, £33 16s. 0d.; free-cutting, £28 16s. 6d. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £32 12s. 0d.; case-hardening, £33 0s. 0d.; silico-manganese, £34 17s. 6d.

Billets, Blooms, and Slabs for Forging and Stamping.—Basic soft up to 0.25 per cent. C, £29 16s. 0d.; basic, hard, over 0.41 up to 0.60 per cent. C, £30 16s. 0d.; acid, up to 0.25 per cent. C, £33 0s. 0d.

FINISHED STEEL

Heavy Plates and Sections.—Ship plates (N.-E. Coast), £30 6s. 6d.; boiler plates (N.-E. Coast), £31 14s. 0d.; floor plates (N.-E. Coast), £31 15s. 6d.; heavy joists, sections, and bars (angle basis), N.-E. Coast, £28 9s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., untested, £32 4s. 6d.; flats, 5 in. wide and under, £32 4s. 6d.; hoop and strip, £32 19s. 6d.; black sheets, 17/20 g., £41 6s. 0d.; galvanized corrugated sheets, 24 g., £49 19s. 6d.

Alloy Steel Bars.—1 in. dia. and up: Nickel, £51 14s. 3d.; nickel-chrome, £73 3s. 6d.; nickel-chrome-molybdenum, £80 18s. 3d.

NON-FERROUS METALS

Copper.—Cash, £232 0s. 0d. to £232 10s. 0d.; three months, £220 15s. 0d. to £221 0s. 0d.; settlement, £232 10s. 0d.

Copper Tubes, etc.—Solid-drawn tubes, 27½d. per lb.; wire, 261s. 6d per cwt. basis; 20 s.w.g., 290s. 6d. per cwt.

Tin.—Cash, £660 0s. 0d. to £662 10s. 0d.; three months, £636 0s. 0d. to £637 10s. 0d.; settlement, £662 10s. 0d.

Zinc.—January, £75 0s. 0d. to £75 5s. 0d.; April, £73 15s. 0d. to £74 0s. 0d.

Zinc Sheets, etc.—Sheets, 15 g. and thicker, all English destinations, £103 2s. 6d.; rolled zinc (boiler plates), all English destinations, £100 17s. 6d.; zinc oxide (Red Seal), d/d buyers premises, £90 0s. 0d.

Lead (Refined Pig).—January, £89 10s. 0d. to £89 15s. 0d.; April, £88 0s. 0d. to £88 5s. 0d.

Brass Tubes, etc.—Solid-drawn tubes, 22¼d. per lb.; rods, drawn, 32¼d.; sheets to 10 w.g., 249s. 3d. per cwt.; wire, 29¾d.; rolled metal, 236s. 0d. per cwt.

Brass (Brazing).—BS1400, B3 (65/35), £163 to £165 B6 (85/15), £205 to £210; BS249, £181 to £185.

Brass (High Tensile).—BS 1400, HTB1 (30 tons), £191 to £205; HTB2 (38 tons), £208 to £212; HTB3 (48 tons), £217 to £222.

Gunmetal.—RCH, 3/4 per cent. tin, £188 to £190; BS 1400, LG2 (85/5/5/5), £195 to £200; LG3 (86/7/5/2), £203 to £208; G1 (88/10/2/½), £260 to £263; (88/10/2/1), £252 to £255.

Phosphor Bronze.—BS 1400, PB1 (AID released), £278 to £285 per ton.

Phosphor Bronze Strip etc.—Strip, 353s. 9d. per cwt.; sheets to 10 w.g., 377s. 6d. per cwt.; wire, 44d. per lb.; rods, 38¾d.; tubes, 37d.; chill cast bars: solids 41d., cored 42d. (C. CLIFFORD & SON, LIMITED.)

Nickel Silver, etc.—Rolled metal, 3 in. to 9 in. wide × .056, 3s. 0¾d. per lb.; round wire, 10g., in. coils (10 per cent.), 3s. 6d.; special quality turning rod, 10 per cent., ½ in. dia., in straight lengths, 3s. 5d. All prices are net.

Other Metals.—Magnesium, ingots, 2s. 10½d. per lb. Antimony, English, 99 per cent., £210 0s. 0d. Quicksilver, ex warehouse, £61 15s. 0d. Nickel, £483 0s. 0d. Aluminium, ingots, £156 0s. 0d.; aluminium bronze (BS 1400), AB1, £251 to £255, AB2, £263 to £268. Solder, brazing, BS 1845, 2s. lb.; granulated, 2s. 3d. lb.